Male combat in *Limnodynastes interioris* (Photo: J. Rowley). See article on page 78.

Strophurus assimilis feeding on *Grevillea* sap at night. See article on page 93.

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REPTILE COMMUNITIES IN VEGETATION REMNANTS OF THE MURRUMBIDGEE IRRIGATION AREA, NEW SOUTH WALES

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ABSTRACT

Reptile surveys were carried out within vegetation remnants of the Murrumbidgee Irrigation Area (MIA). A total of 33 remnants were surveyed between November and December 2003. Twenty-nine reptile species were identified, three of which had not been recorded previously in the MIA. Reptile community composition was influenced by remnant vegetation type and grazing intensity.

INTRODUCTION

The Murrumbidgee Irrigation Area (MIA) is located in the Riverina biogeographic region in south western NSW. The MIA covers an area of approximately 3624 square kilometres and includes the towns of Leeton in the east and Booligal in the west (Figure 1). The MIA contains a diverse range of vegetation communities, including Bimble Box/Pine (*Eucalyptus populnea/Callitris glaucophylla*), Black Box (*E. largiflorens*), River Red Gum (*E. camaldulensis*), Mallee (*E. socialis/E. dumosa*), Boree (*Acacia pendula*), Nitre Goosefoot (*Chenopodium nitrariaceum*), Rosewood/Belah (*Alectryon oleifolius/Casuarina cristata*) and Saltbush grasslands (*Atriplex* spp.) (Eldridge,

Figure 1. The distribution of survey sites within the Murrumbidgee Irrigation Area

- ⊙ Reptile survey sites
- △ Incidental surveys
- ☐ MIA Envirowise boundary

0 5 10 20 30 40 Kilometres

MIA Envirowise boundary supplied by Murrumbidgee Irrigation Corporation
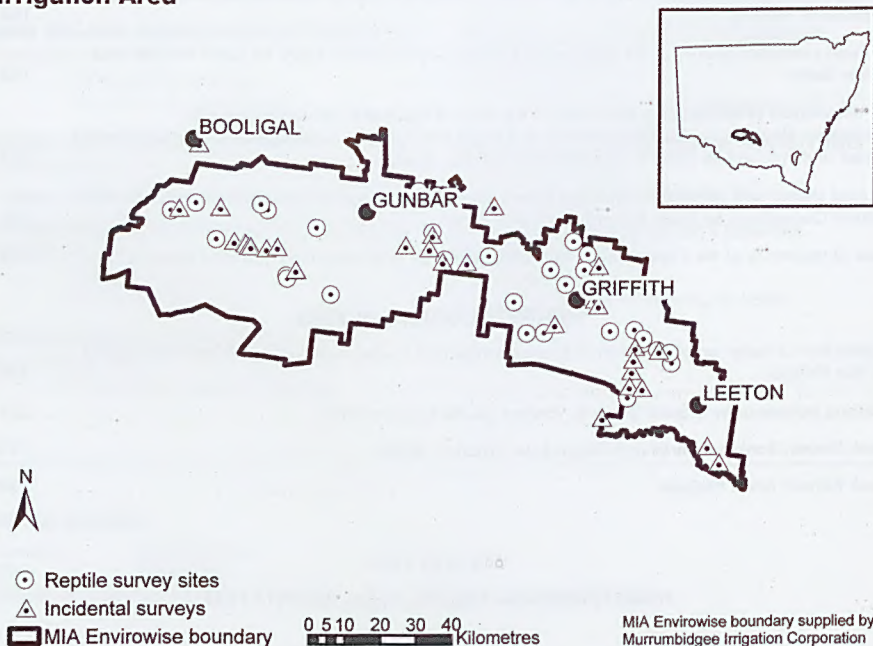
Table 1. The total number of survey sites per remnant type under light and heavy grazing regimes.

Remnant type	Grazing intensity		
	Heavy	Light	Total
Bimble Box/Pine	3	3	6
Black Box	7	5	12
Boree	1	2	3
Inland River Red Gum	1	0	1
Nitre Goosefoot	2	0	2
Rosewood/Belah	1	1	2
Mallee	0	4	4
Saltbush grassland	0	3	3
Total	**15**	**18**	**33**

2002). The climate is semi-arid with an average annual rainfall of 420 mm rainfall, decreasing westwards (Bureau of Meteorology, 2005).

Agriculture and associated irrigation practices have resulted in the vast majority of the native vegetation being removed, altered or degraded (DEC, 2004). Much of the remaining remnant vegetation is in private land tenure with less than two percent of all land in the Riverina bioregion gazetted for conservation purposes (DEC, 2004).

There have been few studies on reptile diversity in southern New South Wales, with the most recent studies by Sass (2003), Daly (2004) and Michael (2004) documenting the reptiles of the south-west slopes and Albury-Wodonga region. The present distribution of most reptiles in the MIA is poorly known with a noticeable absence of museum records and scientific papers dedicated to the region. This paper documents the reptile diversity in the MIA and the relationship between reptile diversity and remnant vegetation in the region.

METHODS

Site Selection

Surveys were conducted within vegetation remnants, which are monitored for biodiversity as part of the MIA Envirowise Program coordinated by Murrumbidgee Irrigation Ltd (Figure 1). A total of 33 sites were selected from the nine vegetation communities Bimble Box/Pine (*Eucalyptus populnea/Callitris glaucophylla*), Black Box (*E. largiflorens*), Inland River Red Gum (*E. camaldulensis*), Mallee (*E. socialis/E. dumosa*), Boree (*Acacia pendula*), Nitre Goosefoot (*Chenopodium nitrariaceum*), Rosewood/Belah (*Alectryon oleifolius/Casuarina cristata*) and Saltbush grassland (*Atriplex* sp.) (Table 1). Fifteen of the 33 sites were heavily grazed (based on the livestock numbers). Remnants ranged in area from 3 to 310 hectares.

Survey Methods

Reptile surveys were conducted from 21-27 November and 15-21 December 2003. Intensive hand searches were conducted at each site. Active animals were located visually, while inactive animals were located by lifting

loose rocks, viewing hollow logs, searches of rock and tree crevices and leaf litter. Searches of anthropogenic materials such as corrugated iron and other building materials were also conducted where they were present. In addition to active hand searches, dry pitfall traps were installed at selected Mallee and Saltbush grasslands remnants. Each pitfall line consisted of three 20 litre plastic buckets and 150 mm high black dampcourse fencing 15 metres long.

Supplement feeding stations (Sass, 2003) were also employed at sites 12, 21, 40, 43 and 44. Canned dog food and sardines were

Table 2. Distribution of reptile species across the nine vegetation communities (includes incidental sightings). * indicates species presence.

	Bimble Box/Pine	Black Box	Boree	Mallee	Nitre Goosefoot	River Red Gum	Rosewood/Belah	Saltbush grassland
Carlia tetradactyla	*							
Chelodina longicollis		*						
Christinus marmoratus						*		
Cryptoblepharus carnabyi	*	*	*			*	*	*
Ctenotus robustus	*		*	*			*	*
Delma butleri				*				
Delma inornata	*							
Diplodactylus tessellatus								*
Egernia striolata							*	
Emydura macquarii						*		
Gehyra variegata	*	*	*				*	
Lampropholis guichenoti	*							
Lerista muelleri	*	*	*	*			*	
Lerista punctatovittata		*		*				
Menetia greyii							*	
Morethia boulengeri	*	*	*	*		*	*	*
Pogona barbata	*	*		*			*	*
Pogona vitticeps	*							
Pseudechis porphyriacus						*		
Pseudonaja textilis		*		*	*			
Rhynchoedura ornata				*				
Strophurus intermedius	*		*					*
Suta dwyeri	*							
Suta suta							*	*
Tiliqua rugosa		*		*	*	*		*
Tiliqua scincoides	*			*			*	
Tympanocryptis tetraporophora								*
Varanus gouldii	*		*	*	*	*	*	*
Varanus varius		*		*				*

placed along transects, with each transect having two feeding stations 40 m apart. Food was placed on the ground adjacent to a possible refuge site such as fallen timber, large rock or grass tussock.

Surveys of each site were conducted for up to 8 person hours. Survey time was reduced at some smaller sites where all areas of habitat had been comprehensively searched prior to 8 person hours. Searches were carried out between 0700 and 2200 hours ESST at temperatures that ranged between 18°C and 35°C. Individuals were identified to species level in the field using Cogger (2000) and Wilson & Swan (2003). Nomenclature for this paper follows Swan *et al.* (2004).

Statistical Analysis

Non-metric multi dimensional scaling (MDS) using Bray-Curtis similarities and analysis of similarities (ANOSIM) (PRIMER version 5) were employed to determine whether the reptile communities from each of the nine remnant community types were different from one another as well as whether reptile communities were different under heavy and light grazing intensity (Clarke & Warwick, 1994). In order to determine which species contributed most to the differences in the communities in different remnant types and under different grazing regimes, we computed the average dissimilarity between communities using Bray-Curtis Dissimilarities (SIMPER). Ranked abundance data was used in all analyses. Rankings are sequential values starting at 1 from the least abundant species and counting up towards the most abundant species. Ranking decreases the importance of very abundant species and ensures that less abundant and rare species influence the dissimilarity between samples (Clarke & Warwick, 1994).

RESULTS

A total of 23 species was recorded across the nine vegetation communities during these surveys with a further six species recorded as incidental sightings (29 species in total) (Table 2).

General community descriptions

Black Box communities had relatively low species richness and were dominated by the more regionally common species such as *Morethia boulengeri* and *Cryptoblepharus carnabyi*.

Bimble Box/Pine sites had relatively high species richness and contained a number of species found in no other vegetation type during this survey. The most abundant species in this community were *Lerista muelleri*, *Gehyra variegata* and *Morethia boulengeri*. *Suta dwyeri*, *Lampropholis guichenoti* and *Pogona vitticeps* were found only in Bimble Box/Pine remnants during this survey.

Mallee sites had high levels of species richness and were generally in good condition. The most abundant species at the Mallee sites were *Tiliqua rugosa* and *Lerista muelleri*. One remnant had a spinifex (*Triodia scariosa*) understorey and contained *Delma butleri* and *Rhynchoedura ornata*, which were not found at any other sites.

Rosewood/belah sites had the highest mean species richness. *Egernia striolata* was only recorded at Rosewood/Belah sites with 15 individuals found. The most abundant species in this community were *Gehyra variegata*, *Cryptoblepharus carnabyi* and *Egernia striolata*.

Boree sites had moderate diversity and were generally dominated by more common and widespread species such as *Gehyra variegata* and *Morethia boulengeri*. This may be a reflection of the poor quality of many Boree remnants.

Saltbush grassland sites had moderate species richness. However three species, *Diplodactylus tessellatus*, *Suta suta* and *Menetia greyii* were unique to these remnants. *Morethia boulengeri* and *Tiliqua rugosa* were the most abundant species in these remnants.

The Inland Red Gum vegetation community was excluded from the ANOSIM model because only one remnant was surveyed. This site had low species richness and low abun-

dance with only one individual each of *Cryptoblepharus carnabyi, Morethia boulengeri* and *Tiliqua rugosa* found.

The Nitre Goosefoot remnants surveyed were of poor quality in terms of microhabitat most likely due to grazing during the drought. This was reflected in the low species richness and abundance of reptile species. Only one *Tiliqua rugosa* and two *Pseudonaja textilis* were found at these sites.

Reptile Community Composition

Overall the type of remnant vegetation community significantly influenced reptile community composition (ANOSIM Global R = 0.54, p = 0.001). But not all pair-wise comparisons of reptile communities in each remnant type were significant. Reptile communities from Black Box remnants were significantly different to those in Bimble Box/Pine, Mallee, Saltbush grassland and Rosewood/Belah remnants (Table 3). Reptile communities in Bimble Box/Pine communities were significantly different to those in Mallee and Saltbush grassland remnants.

SIMPER analysis was used to determine which species contributed the most to the dissimilarity of reptile communities in different remnants. The abundances of four species, *Lerista muelleri, Gehyra variegata, Morethia boulengeri* and *Cryptoblepharus carnabyi* were responsible for much of the dissimilarity

between reptile communities observed in the ANOSIM analysis (see Table 3). In general *Lerista muelleri* was abundant in Bimble Box/Pine, Mallee and Rosewood/Belah remnants. This species contributed 25.1, 28.1 and 12.7 percent of the dissimilarity between Black Box reptile communities and Bimble Box/Pine, Mallee and Rosewood/Belah reptile communities respectively and 24.4 percent of the dissimilarity between Bimble Box/ Pine and Saltbush grasslands. *Gehyra variegata* was abundant in Rosewood/Belah and Bimble Box/Pine remnants and made the largest contribution (25.4%) to the dissimilarly between Rosewood/Belah and Black Box reptile communities and 14.2 percent of the dissimilarity between Bimble Box/Pine and Mallee remnants. *Morethia boulengeri* and *Cryptoblepharus carnabyi* were most abundant in Black Box remnants and together contributed 53.4 percent of the dissimilarity between reptile communities in Black Box and Saltbush grasslands.

Grazing

When remnant type was taken into consideration, lightly and heavily grazed sites contained distinctly different reptile communities (ANOSIM Global R = 0.096, p = 0.024). Sensitivity to grazing pressure varied between species. Eight species contributed 76.5% of the dissimilarity between lightly and heavily grazed sites, of these *Cryptoblepharus carn-*

Table 3. Summary of ANOSIM pair-wise tests of the differences in reptile community composition between different remnant types. Abundances were ranked from 0 to 3. Only significant results have been included in the table.

Pair-wise comparison		R statistic	p
Bimble Box/Pine	Mallee	0.419	0.019
	Saltbush grassland	0.896	0.036
Black Box	Bimble Box/Pine	0.663	0.001
	Mallee	0.764	0.001
	Saltbush grassland	0.754	0.022
	Rosewood/Belah	0.466	0.044

abyi, Lerista muelleri and *Gehyra variegata* were more abundant at heavily grazed sites. *Morethia boulengeri, Tiliqua rugosa, Ctenotus robustus* and *Varanus gouldii* were most abundant in lightly grazed sites.

DISCUSSION

Reptile diversity was relatively high considering that the surveys were conducted during a severe drought period. Several biodiversity surveys such as the Coleambally Biodiversity Benchmark Surveys and the Narrandera Range and Brobenah Hills Remnant Woodland Project biodiversity survey have yielded less than 13 species of reptile (AMBS Consulting, 2000; L. Harrison, pers. comm.). These differences are likely to be a result of the intensive survey techniques and large number of sites surveyed during this study.

Species of significance that were identified during this survey included *Delma butleri, Carlia tetradactyla* and *Tympanocryptis tetraporophora. Delma butleri* (Pygopodidae) is generally regarded as being restricted to areas of spinifex with a mallee over-storey (Sadlier & Shea, 1989; Val *et al.*, 2001, Swan *et al.*, 2004). There are no previous records for *Delma butleri* within the MIA (DEC, 2004; Swan *et al.* 2004). Historical records for this species exist near Lake Cargelligo and Round Hill Nature Reserve, approximately 150 km north of the MIA (DEC, 2004).

Carlia tetradactyla is a common skink of the western slopes of the Great Dividing Range (Swan *et al.*, 2004). It is found within dry woodlands where a grassy ground cover is present (Fischer *et al.*, 2003; Swan *et al.*, 2004). A single specimen was identified in the McPherson Range area north of Griffith. This is the first time that this species has been identified within the MIA. The nearest observations of this species are near Wagga Wagga (Daly, 2004; Caughley & Gall, 1985) and Cootamundra (DEC, 2004) to the east. The identification of *Carlia tetradactyla* during this survey represents a significant range extension for the species.

Tympanocryptis tetraporophora occurs

throughout western NSW extending to the north western slopes and the south western plains (Swan *et al.*, 2004). It inhabits open grasslands and saltbush plains (Swan *et al.*, 2004). The observation of a single animal between Booligal and Hay provides confirmation of the presence of this species, which is at the south-eastern limit of its normal distribution (Swan *et al.*, 2004; DEC, 2004)

During this study, several species of reptile appeared restricted to certain habitat types Many of these species, such as *Pogona vitticeps* and *Suta dwyeri* are habitat generalists and are not usually regarded as being restricted to certain vegetation communities (Swan *et al.*, 2004). Conversely, *Delma butleri* and *Menetia greyii* are habitat specialists to mallee with a spinifex understorey (Sadlier & Shea, 1989) and Saltbush grassland (Swan *et al.*, 2004) respectively.

The apparent habitat restriction of some species of reptile that are generally regarded as generalists is likely to be a response to the widespread clearing of vegetation that has occurred in the past and the subsequent fragmentation of remaining vegetation remnants. The limitations of a 'one off' survey may have also resulted in bias with apparent habitat specialisations with some of these species likely to be found in other vegetation types across the MIA.

Grazing intensity significantly altered community composition with heavily grazed sites dominated by widespread generalist species. These shifts in community composition can result in a reduction of species richness at the regional scale (Driscoll, 2004; Fischer *et al.*, 2004; MacNally & Brown, 2001).

As would be expected, individual species varied in their response to grazing. *Ctenotus robustus* appeared sensitive to grazing pressure and was only found at sites with little or no grazing during this study. This is at odds with the results of previous studies that recorded *C. robustus* at sites subject to heavy grazing (Sass, 2003). This species generally prefers open areas with simple habitat structure (Fischer *et al.*, 2004; Taylor & Fox,

2001). Conversely, *Lerista muelleri* and *Gehyra variegata* appeared unaffected by grazing across the region.

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FATAL INTRA-SPECIFIC AGGRESSION IN FREE-RANGING BLUE-TONGUED LIZARDS, *TILIQUA SCINCOIDES* (SCINCIDAE).

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There are few reports of intra-specific aggression in *Tiliqua* in the wild, all for *Tiliqua rugosa*, all involving the spring breeding season, and all, where the sexes were reported, involving male-male aggression (Hill, 1923; Howe & Tregellas, 1914; Leake, 1962; Bull, 1990; Bull & Pamula, 1996; Kerr & Bull, 2002; see also similar comments on male aggression in the breeding season in this species by Bourne *et al.*, 1986; Greer, 1989; Green, 1999). Here we report a field encounter between two *Tiliqua scincoides*, which proved fatal for one participant.

Our report is based on specimen QMJ57495 in the collection of the Queensland Museum and accompanying donor data. While no collection date was provided, the specimen was registered 20 July, 1993. It is a small female *T. scincoides* from suburban Brisbane, SEQ, measuring 227 mm snout-vent length (SVL). Its ovaries were approximately 15 mm in length with small, non-vitellogenic follicles (~2.5 mm diameter) visible (examined *in situ*). Mature females from Queensland range between 277-359 mm SVL (Shea, 1982). The specimen exhibits a severe traumatic injury to the snout (Fig. 1). Information provided by the donor states the injury was sustained during conflict with a conspecific individual of unrecorded sex and size.

The injury consists of the removal of the snout and upper tooth rows, the point of separation occurring largely along the frontoparietal suture dorsally and the palato-pterygoid suture ventrally, level with the posterior margin of the jugal bones. There is also fracturing through the ectopterygoids and the postfrontals.

The injury is consistent with rotational shear through a plane of weakness as the opponents lock jaws and attempt to flip each other over. Such behaviour has been observed in aggressive encounters in congeneric species *Tiliqua rugosa* and *Tiliqua gigas* (Hill, 1923; Protheroe, 1991).

While there are a number of literature records of intra-specific aggression in *T. scincoides* these are mostly based on captive animals (Klingelhöffer, 1957; Chaumont, 1963; Lundsted, 1968; Barnett, 1977; Matz & Vanderhaeghe, 1977; Evarts, 1979; Field, 1980; Robertson, 1980; Bartlett, 1984). The major aggressive interactions that have been reported are between males in spring (and hence presumably involving establishment of territories or defence of breeding partnerships, Evarts, 1979; Field, 1980), by females, immediately prior to and during parturition, directed to other conspecific individuals (Chaumont, 1963; see also comments on a general increase in aggressive behaviour by females at this time by Sachs, 1957; Matz & Vanderhaeghe, 1977; Munsch, 1979), and between juveniles (Barnett, 1977; Robertson, 1980), often during feeding. Many of these aggressive interactions may have been initiated or exacerbated by the stresses of captivity, particularly overcrowding or limitations on escape.

Most skinks are essentially non-territorial, tending to exhibit active defence of specific sites only. Temporary basking sites and nesting sites are important in this respect (Fitch, 1954; Stamps, 1977; Torr & Shine, 1996). Aggression appears to be more common between males (for example, *Oligosoma otagense*, Coddington & Cree, 1997; *Eumeces laticeps*, Cooper *et al.*, 1987; *Carlia rostralis*, Whittier & Martin, 1992) and the snouts of males are often scarred, presumably from combat with other males (for example, *Eumeces egregius*, Mount, 1963; *Tropidophorus laotus*, Smith, 1923). Aggres-

sion involving females is less frequent. Other than in *Tiliqua* and *Cyclodomorphus*, the only reported female:female encounter that we have been able to identify occurred in *Oligosoma zelandicum* (Richardson, 1962), although an interaction between two *Scincella lateralis* involved at least one female (Brooks, 1967).

The intra-specific encounter reported here is significant as it documents the most extreme physical damage yet recorded from intra-specific aggression between unconfined Australian skinks, although Klingelhöffer (1957) reported a captive *T. scincoides* biting off the upper jaw of a cage-mate and exposing the brain, and a broken mandible was presumed to have resulted from a fight between two unconfined male *T. rugosa* (Kerr & Bull, 2002). Clearly, *Tiliqua* species can be aggressive towards one another in field situations and have the capacity to inflict serious wounds. In the absence of information involving the sex of the other individual, season, availability of food and proximity to favoured basking sites, it is difficult to speculate on the causal factors triggering this interaction.

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Figure 1. QMJ57495, view of head showing severe traumatic injury.
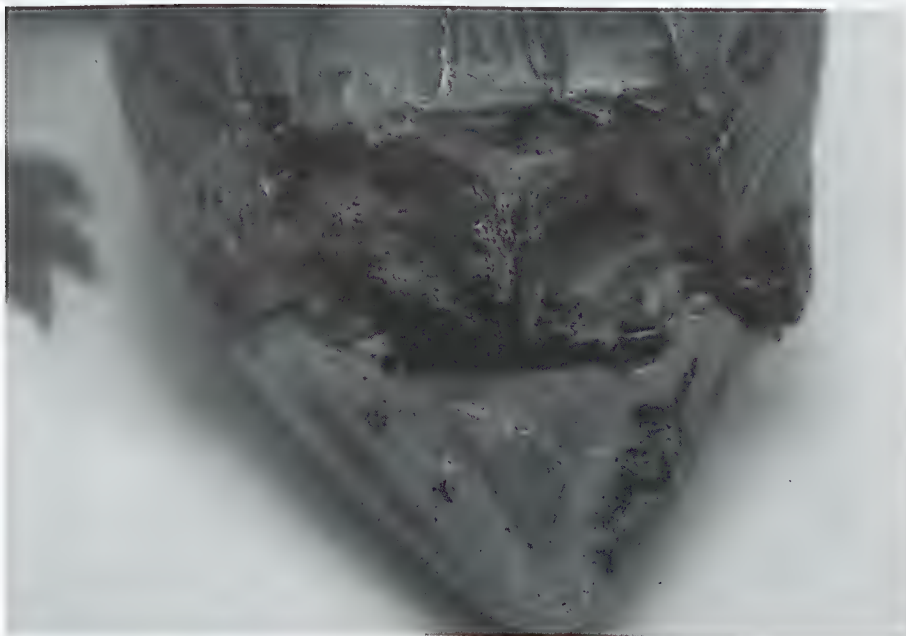
AN AGGREGATION OF THE FLOWERPOT BLIND SNAKE *RAMPHOTYPHLOPS BRAMINUS* AND ITS DISTRIBUTION IN FAR NORTH QUEENSLAND

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The Flowerpot (or Brahminy) blind snake is a small (max SVL 170 mm) species of blind snake that has a widespread distribution throughout tropical southeast Asia and has been inadvertently introduced to many localities, including Australia, where it represents the country's only naturalised exotic snake (Coate, 1997; Cogger, 2000; Maryan, 2001; Wilson & Swan, 2003). It is a human commensal and is often located in compost, garden debris and shallow disturbed soils (Ehmann, 1992; Wilson & Swan, 2003). Within Australia populations are known from the Pilbara coast, Kimberly region, Darwin, Torres Strait Islands and coastal NE Queensland (Wilson & Swan, 2003). The failure to locate any males of the species suggests that they reproduce by parthenogenesis (Nussbaum, 1980). In this note we report on an aggregation of *R. braminus* near Cairns in far north Queensland and suggest, based on this and other occurrences, that the species is well established in parts of the region.

AGGREGATION

The observation (by MA) occurred around midday on 15 July 2004, beside the Bruce Hwy, 11 km south of the Cairns (16°59'44"S 145°44'32"E) in the suburb of Edmonton in an exposed mown grassy strip only 5 m from the highway. Weather was cool and sunny (daytime max 26°C). In the course of using machinery to excavate a hole where the stump of a wooden power pole had previously been, an aggregation of *R. braminus* was unearthed. At a depth of approximately 30 cm, several blind snakes (initially thought to be centipedes when observed at a distance) were scooped-up. On closer examination the hole was found to contain between 30 and 40 blind snakes. These snakes were in direct body contact with each other and ranged in size from approximately 10 to 15 cm in total length. They were initially motionless until earth started to fall back into the hole, stimulating them move and seek refuge amongst the loose soil. While individual snakes were generally similar in appearance, their colouration varied from light grey through light to dark brown. The aggregation was situated in the remnant stump of the pole. Examination of several specimens confirmed that the species was *R. braminus*.

Aggregations amongst the Australian blind snakes have been reported in just three species, have comprised both sexually mature and immature specimens, and have occurred in all seasons except winter (Hoser, 1980; Greer, 1997). The occurrence of aggregations consisting of one adult female and one to three adult males in the months of September through to January in *R. nigrescens* and *R. weidii* has led to the suggestion that aggregations are associated with mating (Shine & Webb, 1990). In one spring aggregation of adult *R. nigrescens* this was confirmed (Scanlon & Davidson, 1999).

Large "colonies" of *R. braminus* in rotting wood have been recorded outside Australia, the significance of which are unknown (Greene, 1997: 151). The aggregation described above is interesting in two respects. First, its occurrence during winter months (albeit, a mild northern winter) and second, the fact the species comprises entirely of females precludes the possibility that the aggregation was associated with mating. The circumstances of the find are consistent with the species' association with modified, rather than natural, habitats in areas where it has

been introduced (Ehmann, 1992), though at least two records of it occupying relatively undisturbed natural habitat exist (Hawkes & Anthony, 1994; Horner, 1996).

DISTRIBUTION WITHIN THE WET TROPICS REGION

Recent published field guides state that the species occurs along the Queensland coast only at Townsville, which lies at the southern end of the Wet Tropics region, and also the Torres Strait islands (Wilson & Swan, 2003; Wilson, 2005). However, it has also been recorded from the tip of Cape York Peninsula (Hawkes & Anthony, 1994). Furthermore, the species is established at Innisfail (17°32'S 146°01'E) (GT, pers. obs.), approximately 215 km north of Townsville, and in the suburbs of Cairns (Redlynch, Woree and others; D. Green and T. Jones, pers. comm.). These observations would indicate that *R. braminus* has a more widespread distribution than previously stated and is well established over much of the coastal plain in the region. Of interest, and presently unknown, is whether the species has managed to establish itself in natural habitats within the Wet Tropics region.

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OBSERVED AGONISTIC BEHAVIOUR BETWEEN MALE GIANT BANJO FROGS, *LIMNODYNASTES INTERIORIS*

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INTRODUCTION

The Giant Banjo Frog, *Limnodynastes interioris*, is a large burrowing frog found in mid-western NSW and at a number of sites within Victoria (Conole & MacNally, 2000). Its taxonomy has been well described (Martin, 1972) and is readily identified by its size, with a snout to vent length up to 90 mm, and by the intense yellow to orange colouring of its flanks and tibial glands. Despite its conspicuous size and colouration, very little is known about the behaviour of *L. interioris*. In particular, there is a lack of information regarding the intraspecific interactions of *L. interioris* during breeding.

There are, however, a few accounts of *L. interioris* advertisement calls and potential breeding sites. For instance, Martin (1972) described the advertisement call of male *L. interioris* as a short "bonk", similar to that of other *Limnodynastes* species. *Limnodynastes interioris* has an apparent preference for concealed calling sites. Males have been documented to call from clumps of vegetation or burrows in the banks of dams, swamps, slow-moving creeks and flooded ditches (Martin, 1972; Watson & Martin, 1973; Anstis, 2002). During dry spells they have been observed aestivating within mounds constructed by Mallee Fowl (Priddel, 1993).

The paucity of behavioural information for *L. interioris* can be attributed to their fossorial nature, typical of the majority of arid-zone frog species (Morton *et al.*, 1993; Read, 1999). As with other burrowing frogs, emergence opportunities are limited by adequate rainfall (Read, 1999; Predavec & Dickman, 1993). Unreliable and infrequent rainfall throughout their range means that appropriate conditions may only be realised every few years and last for no more than a few days. Consequently, the species spends the majority of their lifespan aestivating below the surface. In February 2003, significant rains in central NSW provided an opportunity to observe the behaviour of *L. interioris*.

SITES

Limnodynastes interioris were observed at Weelah State Forest, approximately 50 km SE of Condobolin (33°20'52.6"S 147°12'50.4"E). *Limnodynastes interioris* were observed in two water bodies. The first was a 10-12 m flooded roadside ditch with an abrupt bank adjacent to the road and a gently sloping bank on the opposing side. The bank was broken up by the occasional tree with exposed roots and some fallen trunks. Emergent vegetation was located along the periphery, extending towards the middle of the water body in some places. The maximum depth was approx. 1.5 m. Three male *L. interioris* were observed at this water body. Other frog species observed were *Neobatrachus sudelli*, *Notaden bennetti* and *Litoria caerulea*.

The second water body resembled a dam with a diameter of approximately 15 m. Maximum depth was not determined. The banks sloped at an angle of approximately 30-60°, from a height of 1-2 m above the water surface. Some sections of the bank were truncated or interrupted by trees with exposed roots. There was no other aquatic or terrestrial vegetation within or directly surrounding the water body. At least ten male

and two female *L. interioris* were observed in this water body. *Uperoleia rugosa* and *Litoria rubella* were also present. Most behavioural observations were conducted at this site. Observations were made between 1900-2300 hours on 23 February, 2003.

OBSERVATIONS

In both water bodies, all identified male *L. interioris* (n = 13, identified by nuptial pads) were observed in close proximity to calling sites (either their own calling site, or that of conspecific males). Identified females *L. interioris* were observed in the shallows or amongst emergent vegetation, away from male calling sites. Other individuals were observed towards the centre of the second water body; sex of these individuals could not be determined.

Two distinct calling sites, designated as 'type 1' and 'type 2', were observed. Type 1 sites were hollows formed at the fork of exposed tree roots. Calling males using type 1 sites directed their snout towards the hollow and were easily seen from above while calling. Type 2 calling sites were more concealed and incorporated large tree roots that ran along the bank parallel to the water's edge. These roots could not be seen from above but were readily visible by leaning over the edge of the bank. When viewed from below, the bank in some areas cut away leaving cavities between the root and the bank. A male was observed positioning its upper body into one of these cavities with the head directed towards the root. One male was observed emitting a barely audible "puk" on the water surface before entering the cavity. Once in position a loud resonating "bonk" was heard and felt through the ground surface from above. These calling sites appeared to be greatly contested, often escalating to male-male combat.

Two male *L. interioris* were observed for a half-hour period at a 'type 2' call site. During this time, the following behavioural scenario was observed and repeated approximately five times. While the resident male (call site occupier) was calling, the intruder (a conspecific male of a similar size) swam toward the calling site. The resident male continued to call until it was disturbed by the intruder entering the calling site, at which time combat ensued. At the commencement of each battle a brief low, guttural 'growl' was emitted by the resident male which was audible at times during combat. Initially the resident male using the leverage of the bank, pushed the intruder as far as 20 centimetres away from the calling site. The remainder of the combat was conducted entirely free-floating and involved the individuals inflating and locking arms below the armpit region, with pectoral regions touching (Fig. 1A). Each frog then attempted to submerge their opponent by pressing down on their rivals' snout with the underside of their own head (Fig. 1B). This confrontation was observed to last as long as six minutes, with occasional pauses in activity, but with frogs still clasping to one another. Combat ceased when the loser (invariably the intruder) audibly expelled air, deflated, and fled up to a metre away from the contest site. The winner paused only briefly before returning to the calling site where it resumed calling at similar levels of audibility as heard before the commencement of combat.

DISCUSSION

Physical confrontations between conspecific males of *Limnodynastes* species have been described previously (Clyne, 1967; Bush, 1984). However this paper represents the first documentation of such behaviour between males of the Giant Banjo Frog, *Limnodynastes interioris*. It is also the first to suggest *L. interioris* may defend specialised calling sites but unlike most other frog species that defend calling sites, they may not engage in any pre-conflict rituals.

The close proximity of the conflict to the calling sites suggests the protection of these sites was the motivation for combat. Indeed physical encounters of this kind are often exhibited by frog species that are protective of calling sites (Pengilley, 1971; Wells, 1977,

Figure 1. Two *Limnodynastes interioris* males in combat. A. Inflated males locking arms, chest to chest; B. Top male is attempting to submerge its opponent's head using chin. Photos: Jodi Rowley.
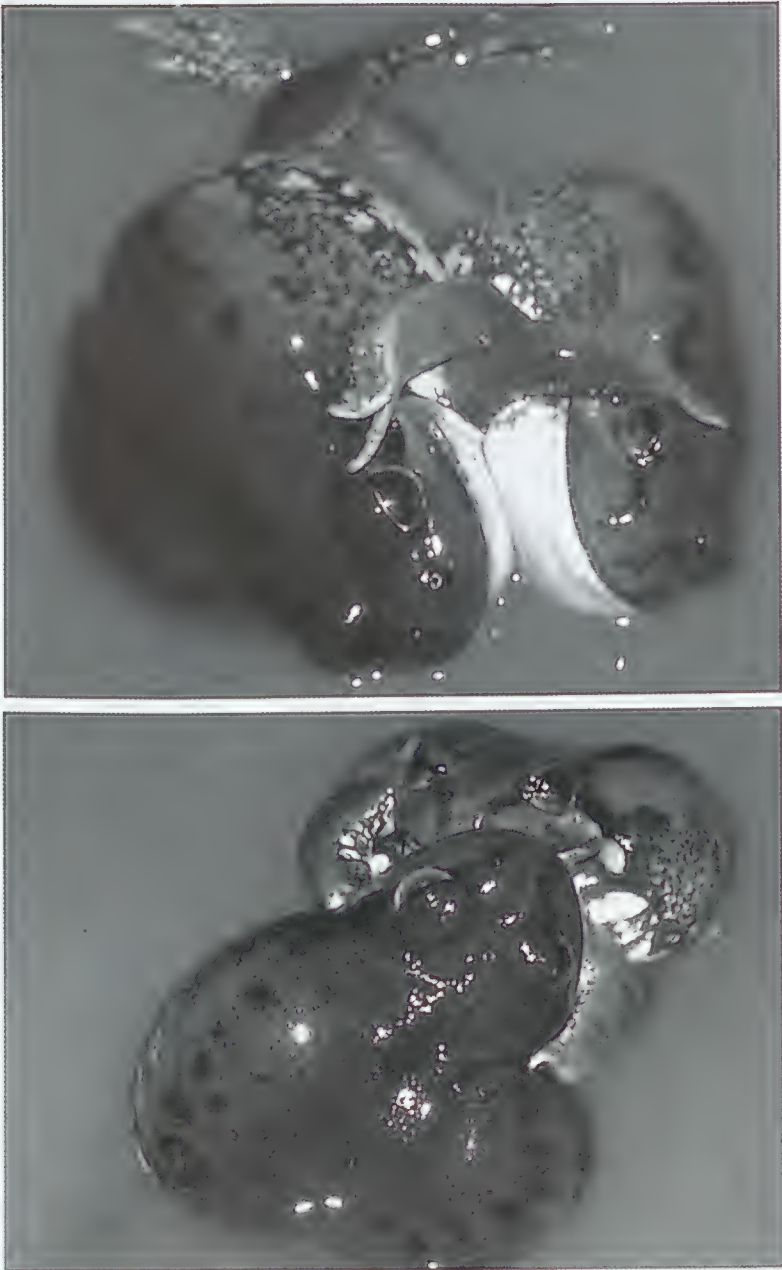
1978; Robertson, 1986; Katsikaros & Shine, 1997). In the case of *L. interioris*, we believe the calling sites are worth defending because they possibly amplify the call of the resident male by virtue of their hollowed-out shape and wooden substrate. This call amplification is likely to elicit a greater response from females searching for large males and/or attract females from further away. Indeed other frog species such as *Heleioporus* (Bailey & Roberts, 1981), *Eupsophus* (Penna & Solis, 1996) and *Metaphrynella* (Lardner & bin Lakim, 2002) have been observed using woody substrates and/or burrow properties to amplify calls.

Although the wrestling bouts observed between males of *L. interioris* seem consistent with observed disputes over calling sites, their lack of pre-conflict rituals prior to combat is atypical. Theoretical models of animal conflict generally predict animals will attempt to assess the fitness of their opponent before engaging in any behaviour that may prove costly (Maynard Smith, 1982). Indeed there are numerous examples in the literature of frogs that engage in 'warning rituals' before combat (Pengilley, 1971; Wells, 1977, 1978; Robertson, 1986; Wagner, 1989; Katsikaros & Shine, 1997; Burmeister et al., 2002). In all of these papers residents responded to intruders by engaging in 'vocal negotiations' whereby the resident altered the nature of their advertisement call or initiated a series of discrete aggressive or encounter calls. In some circumstances these calls were also accompanied by encounter displays such as splashing or posturing (Wells, 1978). More often than not, fighting does not eventuate especially if the intruder or resident is smaller than its competitor (Robertson, 1986). This lack of conflict is attributed to the notion that visual and vocal frequencies relay information used by opponents to assess their potential for success in any given encounter (Davies & Halliday, 1978; Ramer et al., 1983; Robertson, 1986; Given, 1987; Wagner, 1989). Interestingly, the *L. interioris* males observed in this study did not engage in any kind of pre-conflict ritual. Instead the resident was unaware of the intruder until the intruder came in contact with the resident and once the resident was disturbed, conflict was inevitable. So it seemed as if the initial decision for conflict was made by the intruder. Whether or not the intruder uses the resident's call to ascertain its chance for success is unclear and requires further investigation.

There were a number of other aspects of the encounters that have not been documented in other species of *Limnodynastes*, such as the act of submerging the head of the opponent whilst floating on the water surface; in fact this observation has been rarely documented for any frog species (Wells, 1977). Likewise, no other *Limnodynastes* species has been documented as emitting a guttural 'growl' at the commencement of a conflict. However Wells (1978) describes male *Rana clamitans* emitting a low guttural 'growl' at the beginning of a bout. In this example Wells suggested that the 'growl' was a call of intent, serving to declare an imminent attack, and indeed this appears consistent with our observations for *L. interioris*.

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VENOM 'SPITTING' DURING HANDLING IN AN AUSTRALIAN ELAPID SNAKE

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INTRODUCTION

The defensive ejection, or 'spitting', of venom is a well-known phenomenon used by Afro-Asian elapid snakes, including Rinkhals (*Hemachatus haemachatus*) and Cobras (*Naja* spp.) (Greene, 1997; Branch, 1998). The spray of venom is directed at the eyes of the snake's antagonist, and, depending upon the snake species involved, may cause severe symptoms including permanent blindness, pain, swelling of the eyelids, and conjunctivitis (Greene, 1997).

Snakes that habitually spit venom usually have morphological adaptations to facilitate this behaviour. The venom discharge aperture on the anterior surface of each fang tends to be circular, bevelled and smaller than that of non-spitters, and African species even have spiral grooves inside the fangs that act as rifling to further enhance the accuracy of the discharge (Greene, 1997). This defensive strategy appears to have arisen convergently in at least three monophyletic lineages – the Asian Cobras, the African Cobras and the Rinkhals.

Despite having the world's largest radiation of elapid snakes, venom spitting has not been reported for Australian elapids. Here we report an instance of apparent venom spitting under artificial conditions in an Australian elapid.

OBSERVATIONS

Whilst undertaking a project comparing spatial patterns of resident and translocated Tiger Snakes *Notechis scutatus* (Butler *et al.*, 2005), we had cause to anaesthetise these snakes in order to implant radio-transmitters. During this process, one individual (female, approximately 750 mm snout-vent length, 267 g) was restrained by being held behind the head whilst being intubated in readiness for the administration of anaesthesia. We attempted to open the snake's mouth by tapping its nose with a cotton swab. At this point the snake expelled a stream of venom from each fang. Each stream was directed straight ahead of the snake, reached approximately 60 cms from the snake's mouth, and was a continuous stream rather than fine droplets.

This individual was one of the first snakes to undergo surgery during this project, and we were attempting a conscious intubation. Subsequently, we began inducing anaesthesia by gassing the snake in a tube prior to intubation, thus preventing any further chances of the snakes 'spitting' during intubation.

DISCUSSION

Although venom spitting has not been previously reported in Australian elapid snakes, and their fangs are not known to have any particular adaptation for this purpose, this incident demonstrates that this species is at least capable of projecting venom. It is likely that the handler's grip on the snake encouraged the expulsion of the venom. This phenomenon has also been noted during the handling of captive *Notechis* spp., where the cause of venom expulsion is presumed to be pressure from the snake handler on the venom glands (E. Attmarsson, Venom Supplies Pty Ltd, Tanunda, South Australia, pers. comm.). At Venom Supplies Pty Ltd, staff rou-

tinely wear protective eyewear when handling *Notechis* (E. Attmarsson, pers. comm.), and the incident we report here led to a change in practices for those involved in the surgical procedures during our project – people who were potentially in the 'firing line' began to wear protective eyewear.

Potential injuries that may be caused should expelled Tiger Snake venom strike the eyes or skin of a person are not known. However, we strongly suspect that Tiger Snake venom in the eyes would be unpleasant, at the minimum. We caution other herpetologists involved in handling Australian elapid snakes to be aware of the possibility of venom expulsion by these species.

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LIMNODYNASTES TASMANIENSIS, AN ADDITION TO THE HERPETOFAUNA OF THE JERVIS BAY REGION OF SOUTH-EASTERN NSW

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The Spotted Grass Frog *Limnodynastes tasmaniensis* has been reported as having a wide distribution in the coastal areas of southern NSW (Cogger, 2000). However, surveys conducted by the author (Daly *et al.*, 2002; Daly & Senior, 2003; unpubl. data) indicate that south of Sydney the species has been found east of the escarpment only near Moruya (see also Anstis, 2002). As a result of a survey of reptiles and amphibians in the Jervis Bay region of south-eastern NSW we can now report *L. tasmaniensis* in this area.

A pitfall line was set from 21-23 November 2001 in Jervis Bay National Park (AMG 294400 6127600, AHD 10 m) as part of a sampling method to determine the abundance and distribution of reptiles and amphibians in the park. Three pitfall buckets (0.45 m deep and radius of 0.15 m) were set 15 metres apart along a drift-fence that was 0.2 metres high and 30 meters long. Traps were checked daily and animals identified and released.

Two species of reptile and five species of frogs were caught during the pitfall trapping. A total of eight lizards (six Grass Skinks *Lampropholis delicata* and two Garden Skinks *L. guichenoti*) and 21 frogs (three Spotted Grass Frogs *Limnodynastes tasmaniensis*, two Striped Marsh Frogs *Limnodynastes peronii*, eleven Common Eastern Froglets *Crinia signifera*, three Haswell's Frogs *Paracrinia haswelli* and two Tyler's Toadlets *Uperoleia tyleri*) were caught over three days.

Previous surveys in the Jervis Bay area (Daly, 2000) and within a broader region east of the escarpment (Murphy, 1994; Daly *et al.*, 1998; Murphy & Daly, 1998; Scanlon, 2000) had not found *L. tasmaniensis*. The closest known occurrence of *L. tasmaniensis* is approximately 60 kilometres to the west of the study area on the edge of the southern tablelands (Endrick River and Bundanoon, Daly unpubl. data). The presence of *Limnodynastes tasmaniensis* in the Jervis Bay area may have been a result of translocation.

The current observation of *Limnodynastes tasmaniensis* in this area increases the number of amphibian species in the region (Daly, 2000) to 17.

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EVIDENCE OF A JUVENILE SKEWED POPULATION OF CARPET PYTHONS *MORELIA SPILOTA* (SERPENTES: PYTHONIDAE) FROM MAGNETIC ISLAND, NORTH QUEENSLAND

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INTRODUCTION

Carpet pythons, *Morelia spilota* occur throughout tropical eastern Australia in a diverse range of habitat types (Torr, 2000) and persist in high population densities within the suburbs of towns and cities along the Queensland coast (Fearn *et al.* 2001). Extensive geographic variation in mean body size and colouration has led some authors to treat some populations as separate sub-species (Barker & Barker, 1994). However, recent molecular studies (L. Rawlings in Fearn *et al.* 2001) indicate that carpet pythons in eastern Australia represent one highly variable taxon. The *M. spilota* studied in this work are large (to 250 cm SVL, >7 kg) snakes commonly referred to as the 'coastal form' (*M. s. mcdowelli* of Barker & Barker, 1994) by numerous authors.

Previous research on this taxon from southern regions of its east coast distribution have reported that field collected samples contain very few juveniles (Slip & Shine, 1988a; Fearn *et al.*, 2001), presumably because of their small size and highly cryptic colour morphology and habits. Parker and Plummer (1987) state that this is a common problem for most data sets of field-caught snakes throughout the world. This work describes what appears to be a very unusual population of *M. spilota* from Magnetic Island, north Queensland where prey type and abundance appears to impose severe limitations on juvenile recruitment into the adult population. This appears to have resulted in a highly skewed population where juveniles are more numerous, and thus more commonly encountered than adults. A very similar situation is documented for an insular population of carpet pythons off the south west coast of Western Australia (Pearson *et al.*, 2002).

STUDY AREA AND METHODS

Magnetic Island (19°10'S 146°50'E) lies 8 km across Cleveland Bay from the city of Townsville in north Queensland. It is a high continental island with elevations of up to 540 m and an area of 5184 ha. Vegetation consists mainly of open eucalypt woodland with small patches of closed vine forest in sheltered gullies and creek lines. The island is situated in the strongly seasonal wet-dry tropics with mid-summer air temperatures averaging 24.2-31.3°C and mid-winter temperatures averaging 13.6-25.0°C. Rainfall is markedly seasonal and its monthly distribution pattern within the wet season (October to March) varies between years (Australian Bureau of Meteorology). A permanent human population of some 2000 people is situated in the lowland bay areas on the southern side of the island. The majority of the island is relatively undisturbed and almost half its area is National Park.

While *M. spilota* is common throughout nearby urban Townsville on the mainland (S. Fearn, unpublished data), it had not been previously recorded from Magnetic Island (Low, 1978; Covacevich & Couper, 1991), until recognised by the author (Fearn, 1998). The author lived on the island for five months before becoming aware of their presence through a photograph of a juvenile specimen taken by a tourist. Intrigued by the apparent rarity of such a large and well known snake, the author attempted to locate and collect data from as many specimens as possible. Between October 1998 and March 1999 the author drove the single main road linking the settled bays on the southern side of the island nocturnally for an hour at least three days a week to collect specimens crossing the road

or as road kills. In addition, fortnightly searchers were conducted at night along walking tracks in undisturbed parts of the island and appeals through the media were made for island residents to report pythons to the author. Each snake was measured by stretching along a tape measure, weighed, sexed (by eversion of hemipenes), and palpated for ingested prey, faecal samples and the presence of ova in females. Road killed snakes were dissected to examine the contents of the alimentary tract as well as to determine reproductive condition. In addition, the date, time and activities of each snake were recorded. Previous studies have demonstrated that M. spilota in eastern Australia attain sexual maturity at between 130 and 150 cm SVL (Slip & Shine, 1988b; Fearn et al., 2001) so specimens smaller than 130 cm were classed as immature.

RESULTS

Morelia spilota densities on the island appear to be low with only 28 specimens discovered by the author comprising 27 juveniles (475-1183 mm SVL, 81-200 g) (Fig.1) and a single maximal sized male (2462 mm SVL, 7.1 kg)

(Fig. 2). The majority of the sample were females (22) and snakes were collected in every month of the study period. Twenty one were collected nocturnally off the road (five as road kills), four were discovered by householders on verandah rafters (two at night) or concealed among creepers against the walls of houses during the day (two). The single adult male was discovered coiled on a boulder beside a walking track at 2115hrs. Only three of the larger juvenile snakes contained prey or palpated faecal samples. One snake contained a fledgling Indian myna Acridotheres tristis (55 g), another snake (Fig. 3) contained a fledgling bush thick-knee Burhinus grallarius (250 g) and the third snake had unidentifiable bird feathers in its faeces. No evidence of reproduction was found with the exception of the single adult male which displayed distinctive, recently healed male-male combat scars on its fore body. Such scars are unmistakable with experience and take the form of clean cut, straight edged parallel striations. Appeals to the public resulted in only six python captures. One photograph of a very large adult taken several years earlier was given to the author, but remarkably, many island residents were

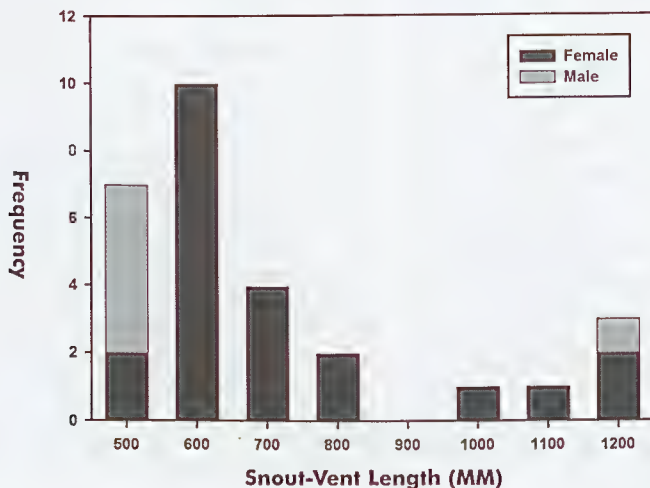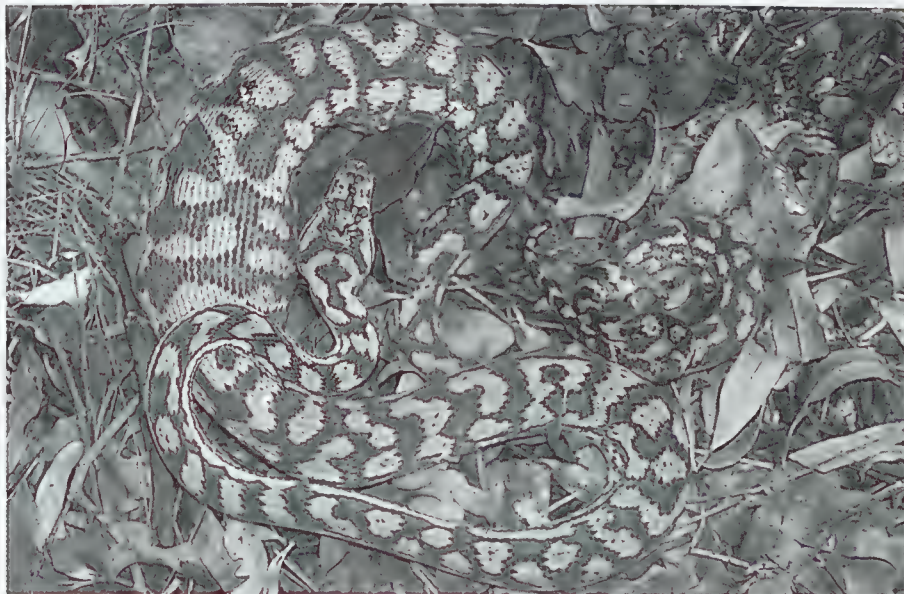**Figure 2. Distribution of body sizes of carpet pythons from Magnetic Island, North Queensland.**

Figure 2. Large adult male *Morelia spilota* from Magnetic Island, north Queensland. Photo: S. Fearn.

Figure 3. Juvenile Magnetic Island *Morelia spilota* distended with ingested *Burhinus grallarius*. Photo: S. Fearn.

unaware of the presence of large pythons on the island with several stating that they had not seen any in >20 years. Others reported no more than one or two encounters nocturnally on the island's roads, observed over periods of 10-20 years before present. This situation is in stark contrast to nearby Townsville on the mainland, where large carpet pythons occur throughout the suburbs and are frequently encountered by members of the public (S. Fearn, unpublished data). The dominance of females in this sample is significantly different from a null hypothesis of equal numbers of each sex ($x^2 = 9.14$, 1 d.f., p < 0.01), but there is not enough information to form a sound hypothesis to account for it. The author has had 25 years field experience sexing snakes using this method and suggests that sampling error can be ruled out.

DISCUSSION

The methods adopted in this study to collect M. spilota undoubtedly introduced biases in terms of which animals were collected. However, in spite of considerable effort on the authors part, the logistical difficulties involved in locating M. spilota when present in low densities should, nonetheless, have resulted in more adult captures, particularly in urban areas of the island. Similar methods adopted for M. spilota in Townsville (S. Fearn, unpublished data) resulted in a large data set of predominately adult snakes. The overwhelming dominance of juvenile animals in this sample is highly unusual and may be the result of the possibly unique assemblage of potential M. spilota prey on Magnetic Island. Morelia spilota displays several ontogenetic dietary shifts from small lizards and mammals at hatching to large mammals in adulthood (Slip & Shine, 1988a; Fearn et al., 2001). There is almost a complete absence of mammals under 500 g on Magnetic Island. The terrestrial mammal fauna is impoverished with only four native species (Brush tail Possum Trichosurus vulpecula, Allied Rock Wallaby Petrogale assimilis, Echidna Tachyglossus aculeatus and Water Rat Hydromys

chrysogaster) and three introduced (Koala Phascolarctos cinereus, Domestic Cat Felis domesticus and Black Rat Rattus rattus) known to be extant on the island. The smallest of these (R. rattus) appears to be restricted to urban areas, is present in low densities and may not be permanently established (Heinsohn, pers. comm.; pers. obs.). Kutt (pers. comm.) recently trapped extensively for mammals on the island and failed to capture any taxa smaller than H. chrysogaster. The smallest native mammal (H. chrysogaster) typically has a mean adult mass of 600-800 g and lives in the vicinity of permanent fresh and brackish water bodies as well as marine beaches (Strahan, 1995). As creeks on Magnetic Island are dry for a substantial part of the year (the dry season from April to September), this rodent is unlikely to be common in the interior of the island. In addition, the young remain at the end of a breeding tunnel for a month before foraging with the mother for a further month while gradually attaining independence (Strahan, 1995). Thus, juvenile specimens are probably difficult to capture for a predominately sit-and-wait ambush predator such as M. spilota. In contrast to the mammals, the island has a rich reptile fauna including some 25 species of lizard (Low, 1978; Fearn, 2001). However, of these, only four (Varanus tristis, Ctenotus robustus, C. eutaenius, Eulamprus tenuis and Tiliqua scincoides) would attain or exceed 10 g in mass.

Morelia spilota on Magnetic Island appear to have access to a range of suitable prey when hatchlings or small juveniles, high densities of brush tail possums and rock wallabies when adult but a significant lack of small mammals for intermediate sized snakes. This appears to result in a population composed mainly of individuals 'trapped' in an ontogenetic dietary gap. It is perhaps significant that the only prey items recorded were commensal birds. While Magnetic Island has a rich avian fauna, all previous studies of M. spilota trophic ecology have found that free ranging birds are rare prey items, presumably because they are difficult for pythons to catch (Slip & Shine, 1988a; Shine & Slip, 1990;

Fearn et al., 2001). Acridotheres tristis is rare on Magnetic Island, possibly not established and confined to urban centers where they nest in the roofs of houses and other buildings. Burhinus grallarius is a relatively large (standing to 500-600 mm) nocturnal species, very common in urban parts of the island where they feed on food scraps as well as invertebrates attracted to lights (pers. obs.). Both these species are more likely to present themselves as possible prey to M. spilota due to their close association with human dwellings, where pythons were discovered by both day and night, as well as the nocturnal habits of B. grallarius which coincide with the main activity period of the snakes.

Intuitively, a large number of juvenile M. spilota in this population would indicate the presence of considerable numbers of reproductive adults. This may, however, not be the case. Large female M. spilota can be highly fecund producing clutches of >40 eggs (data summarised in Greer, 1997). In addition, growth rates of larger juveniles on Magnetic Island may be greatly depressed, resulting in large numbers of snakes 'trapped' in a sub-adult size range and disadvantaged by a lack of small mammals to the extent that the gap from a diet of reptiles and small birds to large mammals, such as brush tail possums, may rarely be bridged. As long as some of these snakes can bridge this gap and take advantage of the high densities of larger prey, selection may continue to favour reproduction at a larger ('normal') body size. A very similar population of M. spilota has been documented by Pearson et al. (2002a) on Garden Island off the south west coast of Western Australia. In this population small and large pythons have 'appropriately sized' prey readily available but intermediate sized snakes, of a very similar size to my Magnetic Island sample, do not. The Garden Island research provides strong evidence that the array of available prey sizes constrains the range of achievable body sizes for carpet pythons. Over an intermediate range of body sizes where the only ingestible prey were small relative to snake size the pythons on

Garden Island were emaciated and grew very slowly. No such effect was detected in other nearby populations, where a wider range of prey size was available to the snakes. These comparisons strongly suggest that python body size in a given area is affected by the size range of available prey (Pearson et al., 2002a,b).

Corroborative data for a lack of small mammals having a direct impact on the demographics of M. spilota on Magnetic Island is provided by sympatric death adders Acanthophis antarcticus (Elapidae). In a previous work (Fearn, 2001), the absence of small mammals appeared to be responsible for smaller mean body size, lower reproductive output and a lack of sexual dimorphism. Sexual size dimorphism is a distinctive trait of A. antarcticus throughout its mainland Australian range where females grow much larger than males (Shine, 1980).

While much of the information in this work is speculative, due to a small and highly skewed sample size, the author's observations on Magnetic Island indicate an unusual situation that warrants further study. However, logistical difficulties (low population densities, rugged terrain) may result in the Magnetic Island population of M. spilota remaining unstudied in any quantitative way. Such a population however, may provide valuable insights into the role that prey types and abundance play in shaping the population structure, survival, recruitment and reproduction of large, gape-limited reptilian predators that undergo clearly defined ontogentic dietary shifts in trophic ecology.

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OBSERVATIONS OF TWO GECKO SPECIES USING TREE SAP AS A FOOD SOURCE

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During a recent field trip 350 km north-east of Kalgoorlie (29°48.715'S 123°54.373'E) in the Great Victoria Desert the following observations were made.

On 27 March 2003 at 7.30 pm two gecko species, *Gehyra purpurascens* Storr, 1982 and *Strophurus assimilis* (Storr, 1988) were observed on a *Grevillea* sp. licking sap. This was oozing from the main trunk about 60 cm above ground level. The night was moonless and overcast with a temperature of 22°C. Both lizards were identified from Storr *et al.* (1990).

The *Grevillea* was situated in a swale between two dunes and was not flowering at the time of the observation. It measured approximately 1.5 m tall and 80 cm wide and was densely crowned. The trunk was open, allowing gecko activity to be easily observed. An adult *Gehyra purpurascens* was observed on the trunk energetically licking sap. The sap had hardened at the point of injury, but fresh sap oozed from beneath the crystallised mass. The fresh sap extended 5 cm down the branch and was 2.5 cm wide. The gecko retreated to the crown of the tree when disturbed.

About 30 cm above the sap was a large female *Strophurus assimilis*. This animal did not approach the sap while the *Gehyra* was feeding. We visited the tree at 15 minute intervals after the *Gehyra* was disturbed. After 45 minutes the *Strophurus* had moved down the trunk and was seen licking sap (Figure 1). This observation only lasted three to four minutes. The *Strophurus* then retreated to the crown of the tree, before climbing down into a clump of *Triodia* at the base of the tree. At 9.37 pm a subadult (approximately 4.5 cm total length) *Gehyra purpurascens* was also observed at the base of the *Grevillea* in a *Triodia* clump.

On the following night, at approximately 7.40 pm this same animal (presumed to be the same from pattern and size) was seen near the sap area on the *Grevillea*. Although it wasn't licking the sap it was only about 20 cm away. The night was fine with a light breeze and a temperature of 16°C. Another adult *G. purpurascens* was seen later in the night on a small tree next to the *Grevillea*.

The observation of geckos feeding on tree sap and other plant resources has previously been reported. Dell (1985) recorded observations of several *Gehyra variegata* licking oozing *Acacia* sap and suggested that *Oedura reticulata* and *Christinus marmoratus* also use plant extrafloral resources. Shea *et al.* (1988) observed several *Gehyra occidentalis* gathered around sap oozing from a *Eucalyptus* tree. Couper *et al.* (1995) report sap licking by *Gehyra dubia* and *Strophurus spinigerus*.

To our knowledge, neither *G. purpurascens* nor *S. assimilis* has previously been recorded using sap as a food source. This observation adds to our knowledge of the wild diets of Australian geckos. Such field observations may have relevance when developing captive diets for these species.

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Figure 1. *Strophurus assimilis* feeding on *Grevillea* sap.

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WINTER AROUSAL OF A HIGH MOUNTAIN SKINK *PSEUDEMOIA RAWLINSONI* FOLLOWING HIBERNATION BENEATH THE SNOW

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INTRODUCTION

Although reptiles occur at high altitude, up to 5500 m in the Himalayas and close to 5000 m in the Andes, they are generally not common in high mountains (Mani, 1990). Despite its lower altitude, the Snowy Mountains of NSW has a 'high mountain' environment (*sensu* Körner & Spehn, 2002), with snow cover for a minimum of a month at the winter snowline (Costin, 1954) to year-round in snow drifts in some years (pers. obs.). The area above the winter snowline (about 1500 m asl), supports 12 species of reptiles (Green & Osborne, 1994), which, although operating at similar body temperatures to related lower altitude species, can become active at lower body temperatures (Spellerberg, 1972b,c). The thermal biology of only one species, *Pseudemoia entrecasteauxii* has been studied in the Snowy Mountains and (in the laboratory) found to have the lowest critical minimum temperature recorded for any Australian skink (Beesley, 1980).

For reptiles in snow-covered environments, hibernation is the only means of surviving the winter. Hibernation may occur deep in the substrate in positive temperatures, or in shallow cover below tussocks or leaf litter where temperatures fall below freezing. The risks of this latter strategy are high, but it allows the animal to respond more quickly to warming following the spring thaw, and thus allows early commencement of summer activity. However, conditions necessary for skinks to become active following hibernation under snow in Australia have not been examined.

The present study reports the capture of a mountain swamp skink *Pseudemoia rawlinsoni* during a winter snow thaw as a bycatch of a subnivean (below snow) study of small mammals.

METHODS

The study area was on a transect that extended from near the winter snowline at Rennix Gap (36°21'S 148°31'E) to Charlotte Pass (36°26'S 148°20'E) near the treeline at the upper end. Each site on the transect had three PVC pipes attached to stakes, with the bottom of each pipe held 50 mm above the ground. The pipes allowed access to the subnivean space without disturbance to the snow pack. Tiny-tag temperature loggers (Gemini Data Loggers) recorded ground surface temperature each hour to the nearest 0.1°C. Snow depth was measured weekly. Mammals were detected using hairtubes placed at the bottom of each pipe for seven days (Sanecki & Green, 2005). Hairtubes were placed on the transect on 19 August 2004, when the snow depth at the site reported here (at 1540 m asl) was 7 cm with a 98% cover of snow within a three m radius. The snow cover had reduced to 2% and the hair tube had a skink adhering to the adhesive tape early on 26 August. The vegetation was wet heath for 15-30 m around the capture point and beyond that was grassland or dry heath and, further away, woodland. All of these had been burnt in February 2003. The ground was waterlogged with no surface rock, logs, nor stumps to provide a deep communal hibernaculum. The vegetation consisted of new growth of forbs and grass tussocks that provided shallow cover only.

RESULTS AND DISCUSSION

The skink was an adult *Pseudemoia rawlinsoni* (57 mm snout-vent length) that normally occurs in bogs, fens, wet heath and wet sod-tussock grassland in the Snowy Mountains (Green & Osborne, 1994). The temperature trace suggested that the snow had thawed

just two days previously (Fig. 1). Before this, there appeared to be a minimum of 22 days of uninterrupted snow cover. The response to the thaw was rapid, with the capture probably occurring by the second day post-thaw (Fig. 1). The skink may have emerged temporarily to hydrate or it may have spent only one night before capture at the surface. However, there was no available deep cover nearby and unless it had travelled a long distance from outside its typical mesic habitat, it would have been hibernating at shallow depth. Green and Osborne (1994) recorded *Eulamprus kosciuskoi* hibernating at 6 cm below a dense mat of grass litter and grass roots. Temperature at such a situation beneath a tussock two km from the present capture point from June to August 2004 averaged 0.4 ± 0.5°C. Once the snow thawed, the temperature in the open fell to a minimum of -6.8°C while beneath the tussock the temperature was -0.9°C. Lowe *et al.* (1971) similarly found that 5-6°C was the maximum thermal buffering provided to the lizard *Sceloporous jarrovi* by its shallow winter microhabitat.

The temperature at which the skink reported here emerged from its hibernaculum is impossible to say. Morning emergence in summer of *P. entrecasteauxii*, occurred at an ambient temperature of 10.2°C or a soil temperature of 6.4°C (Beesley, 1980). The temperature logger in the present study was only above 10.0°C for three hours on 24 August (Fig. 1) suggesting that in a sheltered hibernaculum the temperature was much lower. The temperature at which *P. rawlinsoni* can become active (its voluntary minimum temperature) is not known. This figure will lie above the critical minimum temperature, which for *P. entrecasteauxii* in summer averaged 2.5° to 2.9°C (Spellerberg, 1972a; Beesley, 1980). This figure changes seasonally but was not recorded for winter (Beesley, 1980). However, Spellerberg (1972a) recorded a winter figure for *Lampropholis guichenoti* 1-2°C lower than in summer. Assuming a similar seasonal change, a winter figure of close to 0°C could be expected for *P. entrecasteauxii* and *P. rawlinsoni*, which would be sufficient to enable the skink to leave the minimally thermally buffered hibernaculum for the warmth of the sunshine.

Reptiles inhabiting areas subject to ephemeral snow conditions are probably the most exposed to low temperatures and it is possibly in these that the greatest adaptations to cold

Figure 1. Unshaded temperature at ground level in the week of the capture of the lizard. The line was at about 0°C for 17 days before the record commenced.
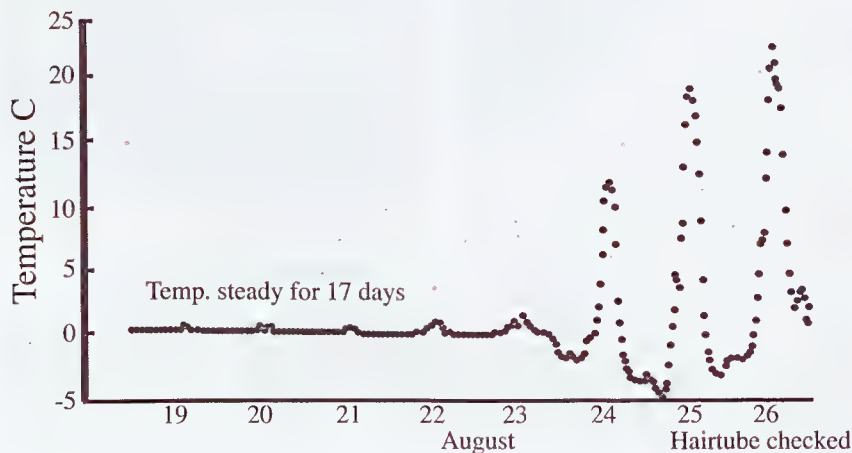
could be found in the Australian herpetofauna. To date, however, the thermal biology of high mountain reptiles in Australia has only been examined in summer (Beesley, 1980). With the recent advances in technology, research on the thermal biology of these reptiles is long overdue.

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OBSERVATIONS OF FRESHWATER CROCODILES (*CROCODYLUS JOHNSTONI*) PREYING UPON CANE TOADS (*BUFO MARINUS*) IN THE NORTHERN TERRITORY

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The cane toad (*Bufo marinus*) is one of the world's most successful invasive species (Lever, 2001). Since they were introduced to Queensland in 1935 they have invaded much of northern Australia and their range is still expanding (van Dam *et al.*, 2002). Cane toads contain high concentrations of the toxin, bufotoxin (Lever, 2001), which is poisonous to most Australian vertebrates. Terrestrial vertebrate predators are particularly threatened by cane toads, because they may be poisoned and subsequently killed during the processes of capturing, ingesting and digesting cane toads (van Dam *et al.*, 2002).

The freshwater crocodile (*Crocodylus johnstoni*) has been identified as a species that is potentially at risk of being poisoned by cane toads (van Dam *et al.*, 2002). This is because freshwater crocodiles are predators that share the same habitats as cane toads. To date there have been reports of dead crocodiles with no external injuries being found in areas occupied by cane toads, crocodiles capturing cane toads and anecdotal reports of wild crocodiles dying after eating cane toads (Covacevich & Archer, 1975; van Dam *et al.*, 2002).

In this note, we report upon observations of predatory interactions between cane toads and freshwater crocodiles during night-time population surveys of saltwater crocodiles (*Crocodylus porosus*) on the Roper and Daly Rivers, Northern Territory during May and June 2005, respectively. The surveys were conducted from a boat using spotlight. Cane toads have been present in the Roper River

Table 1. Predatory interactions between freshwater crocodiles and cane toads observed on the Roper and Daly Rivers, Northern Territory during 2005.

Date	Location	Observation
27/4/2005	Roper River	100 cm TL crocodile observed trying to catch cane toads at the water edge. The crocodile was observed facing the water's edge and lunged onto the shore towards a group of 7 cane toads. No toads were captured.
6/6/2006	Daly River	117 cm TL crocodile found dead with a 120 mm SVL gravid female cane toad in its stomach (Fig. 2). The crocodile had no obvious external injuries.
9/6/2005	Daly River	120 cm TL crocodile with an approximately 120 mm TL cane toad in its mouth (Fig. 3). The crocodile was on the bank, approximately 2 m from the water when sighted.
9/6/2006	Daly River	180 cm TL crocodile with an approximately 100 mm TL cane toad in its mouth. The crocodile was on the bank, approximately 2 m from the water when sighted.

since 1997 (Catling et al., 1998) and in the upper Daly River since 2003-2004. During the surveys, numerous observations were made of cane toads swimming in the water or sitting on the banks of the river in areas where they were likely to be encountered by crocodiles (Fig. 1). A total of 624 C. johnstoni were sighted in eight nights of surveys over 100 km of river. On four occasions freshwater crocodiles were observed to have ingested or caught cane toads, or attempting to catch cane toads (Table 1; Figs. 2, 3). On 3 occasions we were able to photograph these interactions.

These observations confirm previous reports which indicate that cane toads are a prey item for and may be ingested by freshwater crocodiles in the Northern Territory (Covacevich & Archer, 1975; van Dam et al., 2002). Without a more detailed post mortem the observation of a dead crocodile with a cane toad in its stomach cannot be used to conclude that the ingestion of the cane toad was the cause of death. Nonetheless it provides strong evidence that predation on cane toads may result in the death of wild freshwater crocodiles. Previous accounts (van Dam et al., 2002) and experiments (PWSNT, in van Dam

et al., 2002) indicate that freshwater crocodiles are physiologically susceptible to poisoning by cane toads. No studies have yet observed cane toads to have an impact on freshwater crocodile populations (Catling et al., 1999).

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Figure 1. Cane toads (*Bufo marinus*) resting on the water's edge of the Roper River, Northern Territory. Freshwater crocodiles (*Crocodylus johnstoni*) frequently hunt at the waters edge and are therefore likely to encounter cane toads.
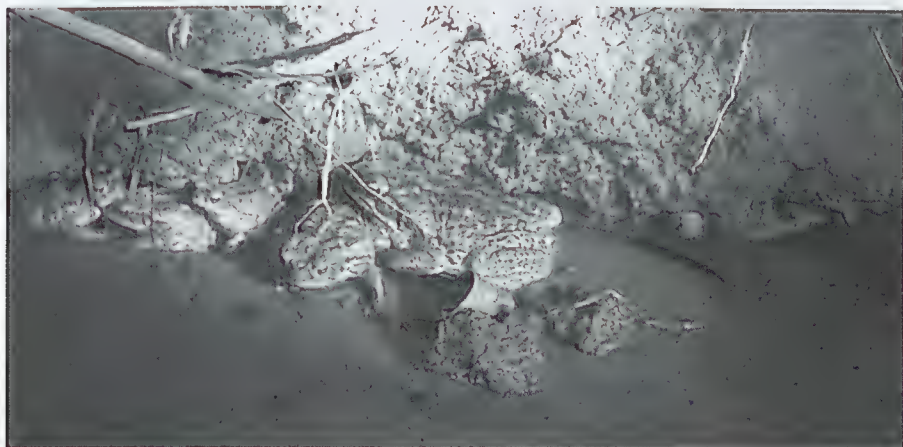
Figure 2. A dead freshwater crocodile (*Crocodylus johnstoni*) found with a cane toad in its stomach on the Daly River, Northern Territory. The crocodile had no obvious external injuries.

Figure 3. An approximately 120 cm TL freshwater crocodile (*Crocodylus johnstoni*) with a cane toad in its jaws. The crocodile and the cane toad were 2 m from the water's edge and dry suggesting that the crocodile may have captured the cane toad on land rather than in the water.

A RECORD OF THE EXOTIC ASIATIC HOUSE GECKO *HEMIDACTYLUS FRENATUS* BEING TRANSPORTED TO ALBURY, NEW SOUTH WALES

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The Asian House Gecko *Hemidactylus frenatus* is a small lizard (average snout-vent length 56 mm) native to much of south-east Asia (Cox *et al.*, 1998). It has established introduced populations in many parts of the world as a result of accidental transport (Morrison, 2003), including south and east Africa, Madagascar, Chrismas Island, New Guinea, Mexico, a number of Pacific islands and Australia (Storr *et al.*, 1990) and is closely associated with urban areas. It is particularly associated with buildings in occupied rather than unoccupied settlements (Cogger, 2000; Whitten *et al.*, 2000).

The year of arrival of the Asian House Gecko in Australia is not known. However, it was first recorded in Darwin, presumably introduced via cargo ships trading from Asia. A little over 30 years ago, it was only known from Darwin (Low, 2001), but today has been recorded from all Australian mainland states except South Australia and Victoria (Swan *et al.*, 2004). In Western Australia it occasionally arrives on ships and aeroplanes at Fremantle and Guildford but has only become established further north, from West Island and possibly Montebello Island in the south (Storr *et al.*, 1990) to the Kimberley region in the north, where it occurs at Broome and Derby (pers. obs., 2002), Kununurra, Argyle Diamond Village, and at Sandfire Roadhouse in the Great Sandy Desert (Wilson & Swan, 2003). In the Northern Territory it has established populations south to Ti Tree, and along the east coast of Australia it extends from Torres Strait to Murwillumbah in New South Wales (Swan *et al.*, 2004; Wilson & Swan, 2003).

In February 2004, two adult Asian House Geckos, one of each sex, were discovered in a removal van that regularly travels between northern states and the southern NSW town of Albury. It was not the first time that the driver of the van had seen pale coloured geckos in his van while unloading cargo in Albury. On this occasion, instead of giving them to local friends, the geckos were given to the local wildlife sanctuary for identification. The geckos were housed at the sanctuary, but did not survive the cool autumn conditions, with the male dying two days after being placed on display and the female dying in April 2004.

While these two geckos were held in unheated conditions, it is possible that the species could survive over winter in Albury indoors in heated houses and establish a population in the region.

The Asian House Gecko is easy to differentiate from the two native species that occur in Albury: the Southern Marbled Gecko *Christinus marmoratus* and the Eastern Stone Gecko *Diplodactylus vittatus* (Michael, 2004). Of the latter two, only the Southern Marbled Gecko climbs walls and windows, and is hence potentially confusable with the Asian House Gecko. Obvious features of the Asian House Gecko are its translucent pale grey colour, almost complete lack of body pattern, enlarged rows of spinose tubercles on the original tail, and inner toes that are greatly reduced in size compared to the other toes. It is extremely vocal and has a loud, distinctive 'chuk uk uk uk' call that can be heard from over 10 m away. Albury's two native geckos have obvious colour and pattern differences, all toes well developed, and although they are able to vocalise, do not call in territorial defence or exhibit overtly aggressive behaviour to conspecifics.

Mainland Australia has only four introduced reptile species, including the Asian House Gecko, compared with 24 mammals, 26 birds and 31 fish (Low, 2001). Although every effort is made to prevent exotic species from accidentally arriving in Australia, some will inevitably be transported across our borders, and whilst it may prove too difficult to eradicate feral populations once established, preventing further spread to new areas is important.

If the Asian House Gecko does become established in Albury, it is unlikely to threaten local reptile diversity, as it appears confined to urban areas. However, as an aggressively territorial species it has the potential to displace the two native reptiles that occur commensally on walls in Albury, the Southern Marbled Gecko and Carnaby's Wall Skink (*Cryptoblepharus carnabyi*) (Michael, 2004).

Anyone who finds an Asian House Gecko in Albury or nearby areas, such as Wodonga in Victoria, or who knows of exotic geckos being kept illegally, should contact the Australian Quarantine Inspection Service (AQIS), New South Wales National Parks and Wildlife Service or the Department of Sustainability and Environment for advice.

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HABITAT OF THE PINK-TAILED WORM-LIZARD *APRASIA PARAPULCHELLA* IN ALBURY, NSW

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ABSTRACT

The nationally threatened Pink-tailed Worm-lizard *Aprasia parapulchella* was first discovered on Nail Can Hill Flora Reserve in Albury during August 2002 (8 individuals) and subsequently, during September (1 individual) and October 2003 (58 individuals), representing one of the largest known populations in NSW. Animals were found sequestered beneath shallowly embedded rhyodacitic rocks and within the brood chambers of dolicherine ants, *Iridomyrmex* sp., in the endangered grassy White Box *Eucalyptus albens*, Yellow Box *E. melliodora* and Blakely's Red Gum *E. blakelyi* woodland community. Lizard sites were similar in terms of aspect, rock type, ant species and disturbance histories, but differ in stand structure, abundance and composition of ground cover. Management may be necessary to control exotic annual plants that may affect thermal conditions available to the lizards. Additionally, the illegal use of motorbikes in some areas may threaten the lizards' habitat through soil erosion and compaction, spreading of invasive weeds and displacement of surface rocks.

INTRODUCTION

The Pink-tailed Worm-lizard *Aprasia parapulchella* was described from specimens collected in the ACT (Kluge, 1974) but received scant attention until the 1990s (McKergow, 1990, Osborne *et al.*, 1991, Osborne & McKergow, 1993). In NSW, it has been recorded from Burra (Robinson, 1996), Bathurst, West Wyalong, Tarcutta (Swan *et al.*, 2004) and Goombargana Hill near Walbundrie (N. Jones, pers. comm. 2001) and in Victoria it is known from a population in the Bendigo region (Wilson & Swan, 2003). It is listed as endangered in Victoria under the Flora and Fauna Guarantee Act 1998, vulnerable in NSW under the Threatened Species Conservation Act 1995 and nationally vulnerable under the Commonwealth Environmental Protection and Biodiversity Conservation Act 2000.

The Pink-tailed Worm-lizard, although not considered a grassland specialist, has been recorded in areas with little tree cover or leaf litter and a good cover of native grasses (Robinson, 1996) but more often from small rocky clearings in open woodland, tall shrubland and disclimax native grasslands (Osborne *et al.*, 1993). A relationship between Kangaroo Grass *Themeda australis* and Pink-tailed Worm-lizard sites has been suggested (McKergow, 1990; Jones, 1992), as has shallowly embedded rhyodacitic and weathered granite rocks (Cogger, 2000; Jones, 1992; Kluge, 1974; Osborne *et al.*, 1991).

It is a cryptozoic, fossorial ant specialist and is known to feed on the various life stages of at least five species of ant and although these species extend beyond the known distribution of the lizard (Jones, 1992; Robinson, 1996), the composition of ant species may play a crucial role in its patchy distribution (Osborne & McKergow, 1993). Soil disturbance has been identified as being a potential limiting factor in its distribution (Osborne *et al.*, 1991). However, the species' ecology, distribution, full range of habitats and responses to disturbance patterns are poorly understood.

We describe the habitat of the Pink-tailed Worm-lizard on Nail Can Hill Flora Reserve in Albury, with the aim of: (1) establishing local baseline habitat data on a threatened species; and (2) facilitating the recognition of potential Pink-tailed Worm-lizard sites in other parts of south-eastern Australia.

METHODS

Records of Pink-tailed Worm-lizards were obtained from: (1) incidental observations by the authors during surveys at site 1, (2) area and time constrained active searches conducted by the authors during a local community biodiversity survey at site 2, and (3) an impact assessment conducted by a local environmental consultant (I Davidson, pers. comm. 2003) with additional active searches by the main author at site 3. Only presence data was collected, during mid morning and afternoon surveys, on warm clear days in spring months.

Specimens were identified using the keys provided in Cogger (2000). Voucher specimens have not yet been lodged with the Australian Museum; however photographic evidence was taken (Fig 1). Statistical analysis was not performed on the data but instead descriptive interpretation of the sites is provided. Floristic composition and structural data were recorded during October 2003 along 100 m transects bisecting the sites and percentage cover of the ground layer was visually estimated from 20 m x 20 m quadrats placed randomly within the sites.

RESULTS

Site 1. At 1748 hrs, on 17 August 2002, a subadult Pink-tailed Worm-lizard was recorded from a rocky clearing on Nail Can Hill Flora Reserve. The temperature was 15°C. Between 1530-1630 hrs the following day a further seven individuals were recorded sequestered individually beneath small surface rocks covering an area of 1 hectare. The site is steep (12°), rocky with a south-westerly aspect (240° SW) and is situated 320 m above sea level (Fig 2). It is bordered above and below by two unsealed service roads and to either side by a gully and an undesignated, eroding walking track.

The vegetation is dominated by Blakely's Red Gum *Eucalyptus blakelyi* with sparse cover of native shrubs and forbs. Kangaroo Grass constitutes approximately 25% of the ground

cover composition (Appendix 1). The average height of the canopy was uniformly 8 m, average canopy width of only 1.2 m, average diameter at breast height was 8 cm and the stem density was approximately 200/ha. Trees were spatially distributed every 2-3 m and the amount of shaded ground from the projected foliage cover was low compared to nearby southerly aspects (15-30%).

The area has been subject to extensive timber removal, grazing and gold mining in the past and has since regenerated in response to reservation in 1915. Hence, the area contains few remnant mature trees and consists mainly of coppice and seed regenerated stands (Fig 1). Many trees are stunted with signs of stress and insect attack and natural thinning is occurring. Fire events are common but are usually small, low intensity outbreaks started under suspicious circumstances.

Site 2. At 0845 hrs on 20 September 2003, during the Albury community biodiversity survey, a single subadult Pink-tailed Worm-lizard was found beneath a small surface rock on a rocky, western facing slope of a drainage line on Nail Can Hill Flora Reserve. The temperature was 16.5°C. The site is moderately steep (9°), rocky with a south-westerly aspect (225° SW) and is situated 220 m above sea level. It is 1.5 km from site 1 and 250 m from site 3. As it may constitute the tail end of site 3 its site description has been included below.

Site 3. During October 2003 a small cluster of Pink-tailed Worm-lizards was recorded adjacent to a proposed development site on Nail Can Hill Flora Reserve. Subsequent investigations between 1330 and 1630 hrs on 25 October 2003 revealed 58 individuals spread across a 1 km ridge line (Fig. 3). The maximum temperature was recorded at 22.5°C. Most animals were found individually but pairs were recorded on eight occasions and groups of three were recorded on four occasions with a range of size cohorts observed in aggregation. The site is steep (14°), westerly facing (280° W) and is situated between 235-265 m above sea level.

The vegetation is dominated by Blakely's Red Gum with patchy cover of native shrubs and Kangaroo Grass. This site is particularly rich in native forbs in parts but intergrades with areas dominated by swards of introduced pasture species (Appendix 1). The height of the canopy ranged from 12-22 m, the canopy width ranged from 10-20 m and the average diameter at breast height was 40 cm. The stem density along the ridge was approximately 10/ha and all trees appeared to be healthy with natural levels of mistletoe. Trees were spatially distributed every 25 m and the amount of shaded ground from the projected foliage cover was low compared to the southerly and northern aspects (15-30%).

This site is mostly located on land managed by the Albury water treatment plant and has been exposed to moderate levels of clearing in the past and recent grazing events. This site is adjacent to site 2 and is separated by an ephemeral creek and small grassy valley (200 m) and is dominated by a mix of native and introduced grasses, although surface rocks are absent.

Rocks and Ants

All sites contain shallowly embedded surface rock and intrusive porphyritic granite outcrops. However, the lizards were only found beneath small, flaky rhyodacitic surface rocks, comprised of granitised schist (C. Michael, pers. comm. 2003). Specimens were found beneath rocks with diameters less than 30 cm and mean widths of 5 cm (very large and deeply embedded rocks were not surveyed). Site 1 contained approximately 50 suitable rocks aggregated within 1 ha, site 2 contained 20 rocks whereas site 3 contained approximately 300 rocks scattered along the ridge. Noticeably, lizards were detected beneath rocks that were situated in open areas away from both the canopy of trees and dense exotic grass cover.

The most abundant ant species, and the ones which appeared to be associated with the lizard beneath the rocks, were small aggressive dolicherine ants of the genus *Iridomyrmex*. Other species were present on all sites but were absent beneath rocks used by the lizards. During the survey periods *Iridomyrmex* sp. contained large broods which were visible within excavated chambers beneath the rocks.

DISCUSSION

The discovery of this significant population of Pink-tailed Worm-lizards in Albury suggests that it may occur in similar habitat in parts of Wodonga in north-eastern Victoria, and may constitute one of the largest known populations on public land in NSW. Much of Nail Can Hill Flora Reserve and surrounding lands have been extensively surveyed for reptiles during different climatic conditions and seasons, with a diverse community having been recorded (e.g. Davidson, 2000; Michael, 2004a,b). Nevertheless, it is possible that the lizard will be detected in other parts of Albury and regional areas in the future. This species is not known to occur in the region based on the distribution maps of current field guides (Cogger, 2000; Wilson & Swan, 2003). However, the Albury population occurs between two disjunct populations occurring in NSW and Victoria, highlighting the need for further research into the distribution of threatened fossorial species.

The population occurs mostly on public land and in areas predominately managed by the Albury City Council for conservation hence, the long-term survival of the Pink-tailed Worm-lizard in Albury would appear secure. This will largely depend on excluding activities that may destroy the integrity of the soil or alter the spatial distribution and thermal properties of the rocks, ant species and associated vegetation. Measures may be necessary to ensure genetic communication is not interrupted and individuals are free to disperse between sites such as: (1) excluding potential development between the sites, (2) preventing damage by motorbikes, and (3) controlling the spread of exotic plant species. Active management to control invasive pasture plants would be beneficial and tools

such as fire and time controlled grazing regimes could be experimentally tested in certain areas.

It would also be of some benefit to monitor the population in a non destructive way before any management activities were undertaken. Substrates such as roofing tiles and fence posts have been used to monitor pygopodids such the Striped Legless Lizard *Delma impar* and Olive Legless Lizard *D. inornata* in Victoria (Michael et al., 2004c; O'Shea, 1996; O'Shea & Hocking, 1997) and NSW (M. Crane, pers. comm. 2002). Data on the conservation value of introducing such substrates is generally lacking for fossorial lizards, although a recent observation of a Pink-tailed Worm-lizard thermoregulating beneath a piece of corrugated iron near site 3 suggests that it may be worthwhile trialling (Fig. 1, D. Michael, pers. obs. 2005). Such substrates may have the potential to increase the carrying capacity of an area, enhance movement patterns, dispersal behaviour and facilitate in monitoring cryptic species without interfering with natural microhabitats through rock-rolling.

Broad similarities have been recognised among the three Pink-tailed Worm-lizard sites, especially in relation to aspect, rock type and companion ant species, but noticeable differences in ground cover composition and stand structure are evident. These differences in part reflect the varying amounts of timber removed, fire histories and grazing patterns in the past. It is encouraging to think, given the complex layers of disturbance the Albury population has experienced, that other populations may exist in similar environments in the region.

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Appendix 1. Dominant flora and percent cover abundance data from Pink-tailed Worm-lizard sites on Nail Can Hill Flora Reserve in Albury, October 2003. * = Introduced native species.

Common Name	Botanical Name	Site 1	Sites 2 & 3
Overstorey Species			
Lightwood	*Acacia implexa*		1
Drooping Sheoak	*Allocasurina verticillata*		10
White Cypress Pine	*Callitris glaucophylla*		1
Blakely's Red Gum *	*Eucalyptus blakelyi*	95	75
White Box	*Eucalyptus albens*	2	5
Red Box	*Eucalyptus polyanthemos ssp. vestita*		5
Red Stringybark	*Eucalyptus macrorhyncha*	3	1
Apple Box	*Eucalyptus bridgesiana*		1
Yellow Box	*Eucalyptus melliodora*		1

Understorey Species

Common Name	Scientific Name		
Cat's Claw Grevillea	Grevillea alpina 'Albury form'	70	5
Box-leaf Wattle	Acacia buxifolia		1
Varnish Wattle	Acacia vernicuflua	15	55
* Ovens Wattle	Acacia pravissima		1
* Cootamundra Wattle	Acacia baileyana		1
Sweet Bursaria	Bursaria spinosa	5	
Narrow-leaf Hopbush	Dodonea viscosa ssp. angustissima		20
Grey Guinea Flower	Hibbertia obtusifolia		5
Small-leaf Bush Pea	Pultenea foliolosa		2
Small-leaf Parrot Pea	Dillwynia retorta	10	5
Sheep's Burr	Acaena ovina		1
Honey-pots	Actrotriche serrulata		1
Wire Grass	Aristida ramosa		5
Chocolate-Lily	Arthropodium strictum	10	15
Rough Spear Grass	Austrostipa scabra		5
Daphne Heath	Brachyloma daphnoides	5	2
Sticky Everlasting	Bracteantha viscosa		5
Yellow Bulbine-Lily	Bulbine bulbosa	5	5
Milkmaids	Burchardia umbellata	5	15
Rock Fern	Cheilanthes austrotenuifolia	5	4
Long-leaf Flax-lily	Dianella longifolia	2	1
Black-anther Flax-lily	Dianella revoluta	5	4
Plume Grass	Dichelachne sp.	3	5
Tall Sundew	Drosera peltata	10	2
Native Geranium	Geranium solanderi	5	2
Common Raspwort	Gonocarpus tetragynus	15	15
Wattle Lomandra	Lomandra filiformis	4	
Urn Heath	Melichrus urceolatus		2
Common Onion Orchid	Microtis unifolia		1
Wood Sorrel	Oxalis perennans	5	1
Cotton Fireweed	Senecio quadridentatus	5	2

Plain Sun Orchid	*Thelymitra nuda*		1
Kangaroo Grass	*Themeda australis*	25	5
Tall Bluebell	*Wahlenbergia stricta*		1
Early Nancy	*Wurmbia dioica*		1

Exotic Species

Hair Grass	*Aira sp.*	5	5
Sheep Sorrel	*Acetosella vulgaris*		5
Scarlet Pimpernal	*Anagallis arvensis*	5	2
Sweet Vernal Grass	*Anthoxanthum odoratum*	10	20
Capeweed	*Arctotheca calendula*		2
Wild Oats	*Avena fatua*	5	20
Sweet Briar	*Rosa rubiginosa*		1
Great Broom	*Bromus diandrus*	5	15
Blowfly Grass	*Briza maxima*	25	15
Lesser Quaking Grass	*Briza minor*	5	5
Slender Thistle	*Cardus pycncephalus*		1
Mouse-eared Chickweed	*Cerastium glomeratum*	5	5
Patterson's Curse	*Echium plantagenium*		2
Common Stork's Bill	*Erodium cicutarium*	3	5
Flatweed	*Hypochaeris radicata*	10	2
French Lavender	*Lavendula stoechas*		1
Pellisar's Toadflax	*Linaria pelisserana*	1	1
Perrenial Rye Grass	*Lolium perenne*		5
Common Bartsia	*Parentucellia latifolia*	1	5
Curled Dock	*Rumex crispus*		2
Clover species	*Trifolium spp.*	20	5
Rats-tail Fescue	*Vulpia myuros*		5

Figure 1. Adult Pink-tailed Worm-lizard *Aprasia parapulchella* found the-moregulating beneath discarded corrugated iron on Nail Can Hill Flora Reserve, less than 50 m from a newly established housing estate in West Albury, October 2005.

Figure 2. Site 1 - Pink-tailed Worm-lizard *Aprasia parapulchella* habitat on Nail Can Hill Flora Reserve, Albury, October 2003.

Figure 3. Site 3 - Pink-tailed Worm-lizard habitat on Nail Can Hill Flora Reserve, Albury, October 2003.

AMBUSH PREDATION POSTURE OF THE CHAMELEON GECKO, *CARPHODACTYLUS LAEVIS*

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INTRODUCTION

The gecko *Carphodactylus laevis* occurs in high altitude rainforests in northeastern Queensland, in the area from Big Tableland north of Cooktown, south to the Herbert River, though it has been recorded in lowland areas as well (Covacevich & McDonald, 1991; Schneider & Moritz, 1998; Schneider *et al.*,1998; Torr, 1998; Wilson & Swan, 2003). It is a relatively large gecko with a SVL of 130 mm, and is readily distinguished by its carrot shaped tail that makes a strange squeaking noise when autotomised (Cogger, 2000). Its biology remains unknown but it is thought to rest during the day in leaf litter, hollow logs, tree buttresses and large epiphytes, becoming active at night where it actively forages on the forest floor, also ascending small saplings in apparent ambush of arthropod prey (Wilson & Swan, 2003). There have been no pictures published documenting these behaviours.

OBSERVATION

On 7 January 2005 at 10:45 pm one of us (TT) observed a female *Carphodactylus laevis* (Fig.1) along the trail to the Tully Falls lookout (17°39'S 145°30'E). This individual was perched head down on a small sapling approximately 1.5 m in height about half a meter from the trail edge. The individual was sexed visually and photographed *in situ* so as not to disturb it.

DISCUSSION

Many species of reptiles and amphibians use prey capture strategies known as sit and wait predation. In most cases the animals that use these techniques are cryptically colored and may possess skin extensions or ridges to hide the animal's outline as it waits for unsuspecting prey (Seipp & Henkel, 2000). This behaviour appears to be consistent with other carphodactyline geckos (*Saltuarius* and *Phyllurus*; Greer, 1989) inhabiting the rainforests of mid/north eastern Australia. These genera exhibit the same head down behavior when encountered under natural conditions (Wilson & Swan, 2003). Although no actual feeding was observed, this head down posture may not be the sole means of prey capture by these geckos, as *Carphodactylus* and *Saltuarius* species are commonly encountered on roads through their respective ranges on warm humid nights, suggesting these geckos may be actively foraging for prey or searching for potential mates.

Figure 1. *Carphodactylus laevis* perched on sapling at night.

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AN OBSERVATION OF THE FORAGING BEHAVIOUR OF THE BLACK WHIP SNAKE *DEMANSIA VESTIGIATA* (SERPENTES: ELAPIDAE): SUCCESSFUL PREDATION OF A FROG *LIMNODYNASTES ORNATUS* (ANURA: MYOBATRACHIDAE) BURIED UNDERGROUND.

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INTRODUCTION

Foraging methods of elapids appear to be related to the body size. While heavy-bodied species such as *Acanthophis* utilise sit and wait methods to ambush unsuspecting prey, thin-bodied forms appear to actively forage for prey (Shine, 1980). Active foraging is typical of a wide range of elapid genera such as *Demansia* (Shine, 1980) and *Pseudonaja* (Shine, 1989). However, observations of wild foraging by elapids snakes are rare and the extent to which actively foraging snakes capture prey remains unclear (Greer, 1989).

The elapid snakes in the genera *Demansia* are long and thin-bodied, with relatively large eyes thought to be an adaptation for capturing fast prey (Shine, 1980). Snakes in the genus subsist predominantly on a diet of ectotherms (Shine, 1980) and appear to be mostly diurnal, although active *D. papuensis* and *D. vestigiata* have been observed at night (Trembath, pers. obs.). Overall, there is very little information on the foraging behavior of the genus. *Demansia papuensis* or *D. vestigiata* has been observed chasing a Gilbert's Dragon *Lophognathus gilberti* in Katherine, Northern Territory (Worrell, 1963) and *D. psammophis* has been observed pursuing a Copper-tailed Skink *Ctenotus taeniolatus* (Greer, 1989). Here we present an observation of a *D. vestigata* successfully preying upon a buried adult Ornate Burrowing Frog *Limnodynastes ornatus*.

OBSERVATIONS

At 1240hrs on 5 April 2005, an adult *Demansia vestigiata* was observed at James Cook University Campus in Townsville, tropical north Queensland. When first sighted, the snake was moving slowly across dirt and leaf litter, in the shade of several shrubs. The snake appeared to be actively foraging, rapidly flicking its tongue and moving slowly for approximately half a metre before halting and rapidly lowering its head to the ground. Upon contact with the ground, the snake began to push its head vigorously into the dirt. This continued for approximately 1-2 minutes as the snake broke through the top layer of the dirt it continued to bury its head at least 5-10 cm into the ground before emerging with an adult *Limnodynastes ornatus* (approx. 40 mm snout-vent length) head-first in its mouth. The snake proceeded to swallow the frog over the course of several minutes. There did not appear to be a visible burrow entrance and the ground appeared to be relatively hard, as indicated by the amount of effort taken by the snake to reach the frog. We did not disturb the snake, allowing it to feed and subsequently move away into a nearby creek bed. At the time of observation, the air temperature was 30.6°C, the substrate temperature was 30.4°C and relative humidity was 49%.

DISCUSSION

Demansia species are known to locate their prey items visually during the day and then capture them by direct chasing (Shine, 1980). While *Demansia* mostly eat lizards, the presence of frogs and geckos in their diet (Shine, 1980) indicates that they may be able to forage nocturnally or be able to locate noc-

turnal prey items in the daytime. The present observation provides suggests that *D. vestigiata* is able to locate nocturnally active animals in their retreat sites during the day by smell.

Approximately 35% of Australian frogs can burrow (Tyler, 1994), spending dry periods in a dormant state, burrowed well below the ground surface (Barker *et al.*, 1995). *Limnodynastes ornatus* is one such burrowing species, and is usually found on the surface only after rain or on warm, humid nights (Cogger, 2000). Prior to this observation, the Townsville region was experiencing below-average rainfall (Australian Bureau of Meteorology), with no significant (>10 mm per day) rainfall for more than two months (Australian Bureau of Meteorology), and little burrowing frog activity (Rowley, pers. obs.). The individual observed in the present study was therefore likely to have been buried for at least several weeks and be a true representative of a dormant burrowing frog in an underground retreat site.

That *D. vestigiata* is able to locate burrowing frogs diurnally, when they are unlikely to escape predation attempts, may be a much more effective foraging technique than actively foraging for lizards, especially during the dry season. During much of the year, burrowing frogs in underground retreat sites are likely to represent an extremely abundant food source for snakes (34-200 frogs per ha in arid areas; Morton *et al.*, 1993; Read, 1999). Therefore it makes sense that *D. vestigiata* has evolved an ability to use this resource. For frogs, this observation indicates that they may be predated throughout the year, and not only during brief periods when they are active above-ground. Selection of burrow location and characteristics may therefore have important implications for predation risk.

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DIURNAL SHELTER SITES SELECTED BY BREEDING GREEN-STRIPED FROGS *CYCLORANA ALBOGUTTATA* ON CURTIS ISLAND, CENTRAL COASTAL QUEENSLAND

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Although it is widely acknowledged that amphibians use a range of terrestrial habitats adjacent to wetlands and streams (most of these relate to foraging, refuge or overwintering sites) there are comparatively few published accounts of species specific use of these habitats. We report here on observations of shelter sites used by a breeding aggregation of Green-striped Frogs *Cyclorana alboguttata* on North Curtis Island.

Cyclorana alboguttata is a relatively slender hylid frog reaching 83 mm in length for females and 67 mm for males (Tyler, 1974). It is brown or green above with scattered darker flecks and blotches and often with a light yellowish or green vertebral stripe (Cogger, 2000). The species occurs along the Queensland coastline, extending inland for varying distances and penetrating northern NSW (Tyler, 1974).

The burrowing habit of this species is noted in a number of published accounts (Sanders & Davies, 1984) and habitats are broadly described as woodland and cleared areas (Robinson, 1994), temporarily inundated grassland (Barker *et al.*, 1995) and open forest and grassy edges of temporary ponds (Cogger, 2000). *C. alboguttata* forms a water-proofing cacoon while buried underground and dormant (Glasby *et al.*, 1993). To our knowledge there are few detailed published accounts of terrestrial habitats (specifically shelter sites) used by this species at breeding sites.

In December 2003, whilst conducting baseline vertebrate fauna surveys on Curtis Island (23°31'42"S 151°10'58"E), we recorded a substantial number of *C. alboguttata* sheltering under rocks on exposed rocky slopes between 15-50 m from the edge of a known ephemeral breeding site (flooded grassland).

The slopes were devoid of vegetation (this appeared to be a natural phenomenon) and supported a variety of rock sizes ranging from approximately 5 cm to over 50 cm in length. The geology of the observation site was metamorphosed rocks (forming low hills) with shallow soils.

Shelter sites (20-25 were observed) selected by *C. alboguttata* generally consisted of partially buried, flat rocks with a visible entrance to the chamber on the downslope side. In some cases *C. alboguttata* appeared to excavate appropriately sized depressions (to body size) beneath suitable rocks. Although we made no direct observations to support this behaviour, the frogs fitted so neatly within the chamber that this seemed the only plausible explanation. Some frogs utilised rocks in direct contact with underlying rocks. In one instance *C. alboguttata* was recorded sheltering beneath a large Cane Toad (*Bufo marinus*) which had also sought shelter beneath a large rock. The substrate beneath the rocks was moist.

C. alboguttata generally sheltered individually, although four groups of 2-3 frogs were observed. Other species present with *C. alboguttata* were the Desert Tree Frog (*Litoria rubella*), Bynoe's Gecko (*Heteronotia binoei*) and the skink *Carlia munda*.

Although obvious shelter sites (shrubs, logs, rocks etc.) were largely absent from the margins of the flooded grassland, large choruses of *C. alboguttata* were recorded on consecutive nights, suggesting that at least a portion of the local population migrated daily from the nearby exposed rocky slopes to potential breeding sites.

The rocky slopes are obviously important shelter sites to the local population of *C. alboguttata* at least seasonally. Unfortunately, no observations of these shelter sites during dry (non-breeding) periods has been made, although continued use of the sites must be considered likely.

The approach taken in conservation planning for amphibian populations often places a strong emphasis on the retention of "core" habitats, typically comprised of the "wettest" wetland or waterway sites. Clearly such an approach can be inadequate, given that terrestrial habitats surrounding the breeding site are also heavily utilised by some species. In this case surrounding terrestrial habitats were found to support concentrations of *C. alboguttata* to a distance of at least 50 m from the water's edge. It is likely that the frogs dispersed further through the surrounding habitats post breeding, although this was not confirmed. Much research is required regarding the terrestrial habitat use of Australian amphibians to adequately set habitat conservation targets, in terms of both the area and habitat types conserved.

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LACK OF RESISTANCE OF THE COPPERHEAD (*AUSTRELAPS SUPERBUS*) TO ITS VENOM

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Resistance of snakes to their own venom is regarded as normal, with this resistance extending to others of the same species (Hoser, 1985) or sometimes even similar species (Hoser, 1996). Cases not fitting this profile are rare and warrant reporting. Such a case is documented here.

In March 2004, I obtained two male Lowland Copperheads (*Austrelaps superbus*) from a litter of eight born 5 March to a female from Apollo Bay, Victoria. At birth both snakes had a total length of 20.5 cm, with the six other siblings measuring 19.5, 19, 19, 18.5, 18.5 and 18 cm in total length. The two snakes were housed together and force- or assist-fed a diet of fish and mouse legs. They grew rapidly, and by 15 May 2004, each had a total length of 32 cm.

At 7 p.m. on 16 May 2004, one snake was observed biting the other on the mid-neck. Neither the snakes or their cage had been moved or disturbed in any way prior to the observation. The bitten snake died within 15 minutes. It made some agonizing twists and turns prior to finally dying in an upside down position. The bitten snake made no attempt to retaliate by biting its sibling.

Both snakes were immediately pre-slough (cleared eyes) and the reason for the bite is unknown. Cannibalism was excluded as a possibility, because at no stage did the biting snake attempt to eat the other.

While in the care of another keeper, two other snakes from the same litter allegedly bit one another and also died rapidly.

These cases, together with that reported by Hoser (1985), involving an adult Highlands Copperhead (*Austrelaps ramsayi*) biting an adult Lowlands Copperhead (*Austrelaps superbus*), imply that Copperhead species are not resistant to their own venom.

This could raise problems for husbandry of Copperhead species, and it is recommended that Copperheads be kept apart unless breeding or the snakes have had their venom glands removed.

Perhaps a more important question is whether or not the cases documented here and in Hoser (1985) are unusual or typical of the genus *Austrelaps*. That lack of resistance to venom in this genus may be typical is suggested by field observations of male combat in *Austrelaps* (Jenner, 2004, and references therein). All three species of this genus are unusual among Australian elapids in that males hold their heads and necks away from one another and no biting is observed. This is in stark contrast to species such as Blue-bellied Black Snake (*Pseudechis guttatus*) and Collett's Snake (*Pseudechis colletti*), in which males aggressively bite and envenomate one another (see photos by Hoser in Eipper, 2002, for an example of this). The biting in these species is vigorous and intense in that males hold on to the other snake as best they can and apparently "pump" their head and venom glands in the same way as when live food is taken, so envenomation is inferred.

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CANDY FROM A BABY: AN OBSERVATION OF KLEPTOPARASITISM OF A WASP NEST BY *CRYPTOBLEPHARUS VIRGATUS*

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The genus *Cryptoblepharus* represents a group of small, diurnal skinks, widely distributed but with six species currently recognised in Australia (Cogger, 2000). The Australian species are either saxicoline or arboreal (with the exception of *C. litoralis*) (Cogger, 2000).

While dietary information is scarce, it appears that most species of *Cryptoblepharus* are insectivorous, actively foraging for their prey. However *Cryptoblepharus*, perhaps uniquely in Australian skinks, has also been reported to engage in theft of food from insects. Greer (1989) reports observations of *C. virgatus* stealing food from ants returning to their nest. This paper reports an observation further extending this food-robbing behaviour to include theft from mud-wasps (Hymenoptera, Eumenidae or Sphecidae).

Mud-wasps are widespread in Australia with numerous species represented. Among other nesting modes, some members of the Eumenidae and Sphecidae construct gourd shaped mud nests – commonly on the sides of buildings. Females hunt diurnally for arthropod prey which they paralyse or kill with a sting. They pack their nests with these food items, lay an egg inside and seal the nest. The wasp larvae hatch and consume the waiting food before pupating and emerging from the nest as adult wasps (CSIRO, 1973).

In February 2002, I observed an individual *Cryyptoblepharus virgatus* on a wall under a house in Hurley Street, Lismore (northern NSW). The skink was initially observed foraging in a crevice between two timber beams at the top of the wall. The white fibro wall also supported numerous mud-wasp nests. The skink was observed to make a direct movement of approximately 0.8 m from the crevice to an open wasp nest in the centre of the wall.

The skink was then observed to enter the nest with its head before backing out grasping a small arthropod and retreating to its initial wall crevice with the arthropod uneaten in its mouth. Approximately 5 minutes later a wasp returned to the open nest with an arthropod prey item and packed this into the nest.

This observation establishes nest robbing as another strategy for food acquisition in *Cryptoblepharus*. Beyond this simple fact it is difficult to speculate. Systematic observation would be necessary to determine the frequency of this behaviour and thus its importance to both the wasp and the lizard. Interestingly, on other occasions at the same locality I have observed this species of wasp sealing nests only to unseal them later and continue provisioning the nest with food. Such behaviour suggests that nest robbing by some agent is sufficiently common as to require a level of amelioration from the wasp. It is possible that lizards constitute an important threat to maternal provisioning by mud-wasps and that female mud wasps provide an important source of food for the lizards.

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SOAKING BEHAVIOUR BY A SAND GOANNA, *VARANUS GOULDII*

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Reptiles such as Bearded Dragons (*Pogona* sp.) are known to soak in naturally occurring puddles (Sue Davis, pers. comm.). Soaking in water may aid shedding and control of ectoparasites. This is a report of a wild Sand Goanna (*Varanus gouldii*) observed near Wagga Wagga, NSW, creating its own puddle during rainfall.

On 5 November 2004 there was moderate rain (29.4 mm over 24 hrs) and warm temperatures (16.4°C at 0900 hrs) (rainfall records for Wagga Wagga airport; NSW Bureau of Meteorology records). At 0700 hrs, whilst rain was falling, an adult Sand Goanna (sex unknown) was observed at the entrance to its burrow in granitic gravel. It had positioned itself so its head was protruding. Its lower body plugged the entrance to the burrow so the rainwater formed a shallow puddle in the depression. The goanna's eyes were closed and it remained very still in this position for at least 10 mins (Fig. 1). On previous occasions, the goanna had been observed entering and exiting this burrow with ease, so its body would normally be less than the diameter of the burrow. It is presumed the goanna blocked the entrance by expanding its rib cage.

Approaching the goanna caused it to retreat backwards quickly into its burrow, and the puddle of water drained down the hole. Within 2-3 minutes the goanna re-emerged to the same position, and the puddle reformed in the rain.

It is unclear if the goanna was deliberately creating the puddle in order to soak, or was emerging from and blocking the entrance to a burrow that was filling with water. However, there were no natural pools of water within 15 metres, and none within an extensive area that offered the same proximity to safe haven if the lizard needed to escape from threat.

ACKNOWLEDGMENT

Figure 1. Sand goanna soaking at burrow entrance.

BOOK REVIEW: SNAKES, LIZARDS AND FROGS OF THE VICTORIAN MALLEE

Mike Swan and Simon Watharow are herpetologists well-known to the Australian herpetological community, the former a long-standing member of Melbourne Zoo Herpetofauna Department and the best specialist source of herpetological literature in Australia, and the latter current President of the Victorian Herpetological Society and author of several papers on reptiles; this is their first book.

An important distinguishing feature of the present work is its coverage of a defined habitat-type, mallee; it is the first such herpetological guide in Australia, albeit confined to the Victorian segment of this habitat. This is a departure from previous Australian herpetological books which have a national (eg., Cogger, 2000), state (e.g., Swan et al., 2004), regional (e.g., Bush et al., 1995; Griffiths, 1997) and/or systematic group (e.g., Horner, 1992) focus, and hopefully sets a trend for future works by authors on other habitat-types. The book reviewed here is also the first to include complete photographic coverage of the frog larvae in the constituent herpetofauna, and I suspect most future Australian books covering these two vertebrate classes will follow this trend, after the foundational work by Anstis (2002).

The book has Foreword, Preface, About the authors, Acknowledgements, Contents, Introduction to the Victoria Mallee, species accounts, a Checklist of Victorian Mallee Species, Victorian conservation categories, survey methods, Glossary, References, Further information, Snakebite and first aid, Snake prevention around the house, and Index sections. The 56 species accounts are systematically organised under order and family headings, with line drawings illustrating

salient features of the family at the beginning of each family section. There is one species account per page for each of the taxa recorded from the study area, each comprising common name, Latin name, description, habitat, habits, call (frogs), tadpole (frogs), locations, and Victorian conservation status, accompanied by an inset with diagnostic features of the species, colour photograph(s), and point distribution map; the gecko accounts each have diagnostic line drawings of the ventral foot surface. Also provided are brief accounts of species from habitats peripheral to the study habitat-type (24 spp.), each given with a colour photograph, brief biological summary, and Victorian conservation status; these include tortoises from watercourses in these peripheral habitats.

The geckoes *Nephrurus levis* and *Strophurus elderi* and skinks *Eremiascincus* spp. have been recorded from mallee/porcupine grass habitat in southwest New South Wales (Shea & Wells, 1983; Swan et al., 2004); it appears that the Murray River has been and is currently an effective southern barrier to dispersal of these taxa. I was particularly struck by the close resemblance of one of the morphs of *Pygopus lepidopodus* (p. 29 top) found in the region to the common morph found in south-west Western Australia, which may indicate relatively recent gene-flow in this species across the two regions.

There is a remarkable absence of typographical and spelling errors in this work; I tried hard to find at least one to cite in this review, but could not until I eventually noticed the incorrect spelling of the describer's name 'Schlegel' (given as "Schlegal") in the entries for *Demansia psammophis* and *Echiopsis curta*. Other trivial errors include failure in

some cases to include the describer's name in brackets with the publication date where the species is currently assigned to a different genus to that in which it was described (*Tiliqua rugosa aspera*) or the incorrect placement of brackets around the date of publication when there has been no change in genus (*Ctenotus brooksi iridis, Ctenotus orientalis, Amphibolurus nobbi coggeri*). The book includes all geckoes under the familial name Gekkonidae, rather than placing many of them in Diplodactylidae (the latter applicable to six of the species covered), however this change (see Kluge, 1967) is yet to receive much acceptance by herpetologists.

The quality of reproduction of the colour photographs in this book is superb. I like the A5 format of the book, printed using high-quality matt paper. The recommended retail price ($29.95) should be well within the budget of even the most impoverished herpetologist, such as in the case of this reviewer. I unhesitatingly recommend this fine book.

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BOOK REVIEW: ASIAN PITVIPERS

By A. Gumprecht, F. Tillack, N.L. Orlov, A. Captain and S. Ryabov, 2004.
368 pp., approx. 1200 colour photographs
Published by GeitjeBooks Berlin (www.geitje-books-berlin.de)
R.R.P. 59,00 Euro (~ A$95), IBSN 3-937975-00-4

Sections:

Foreword

Acknowledgments

Introduction (materials and methods, abbreviations, glossary)

English common names

Table with selected pholidotic data

Annotated check list (currently valid nomenclature and systematics, citation of the original description, information on type material, distribution, as well as explanatory comments)

Colour plates (including detail and habitat photos)

Literature

Systematic index

Photographic credits

The photography in this book is simply breathtaking and worth the purchase price alone. However, the book is also a tremendously valuable resource. Type locality for each species is given as is the location for the type material. This makes any changes in taxonomy very easy to reconcile. The taxonomy is rigorous and precise. Included is a table cross-referencing the *Trimeresurus* complex with the recently proposed splitting of the genus into multiple genera by Malhotra and Thorpe in 2004, based upon genetic data combined with almost unparalleled variation in hemipene morphology. This book is strongly recommended for anyone with an interest in this diverse group of venomous snakes and will be of use to all levels of education.

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NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers. Priority is given to articles reporting field work, observations in the field and captive husbandry and breeding.

All material must be original and must not have been published elsewhere.

PUBLICATION POLICY

Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonomic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

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Use the Concise Oxford Dictionary for spelling checks.

Photographs – black and white prints or colour slides are acceptable.

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A computer disc may be submitted instead of hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCII. Any disc must also be accompanied by hard copy.

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Adult male (top) and juvenile (bottom) Carpet Pythons (*Morelia spilota*) from Magnetic Island, Queensland. (Photos: S. Fearn). See article on page 87.